Pre-Stack Pro
Getting started guide

Version 4.4

sharpreflections
INTERACTIVE PRE-STACK

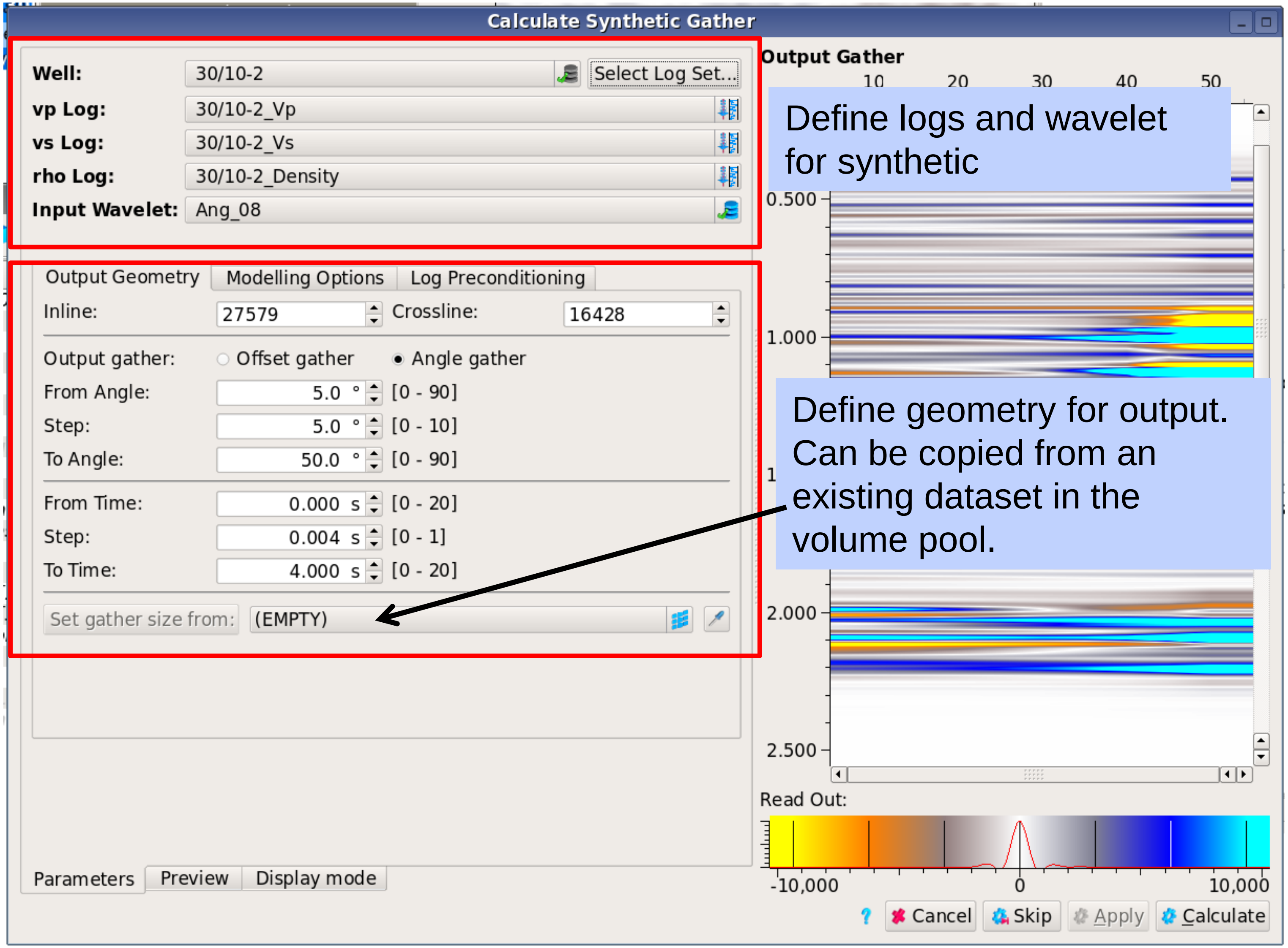
Contents

- **New Features**
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    - Velocity Converter
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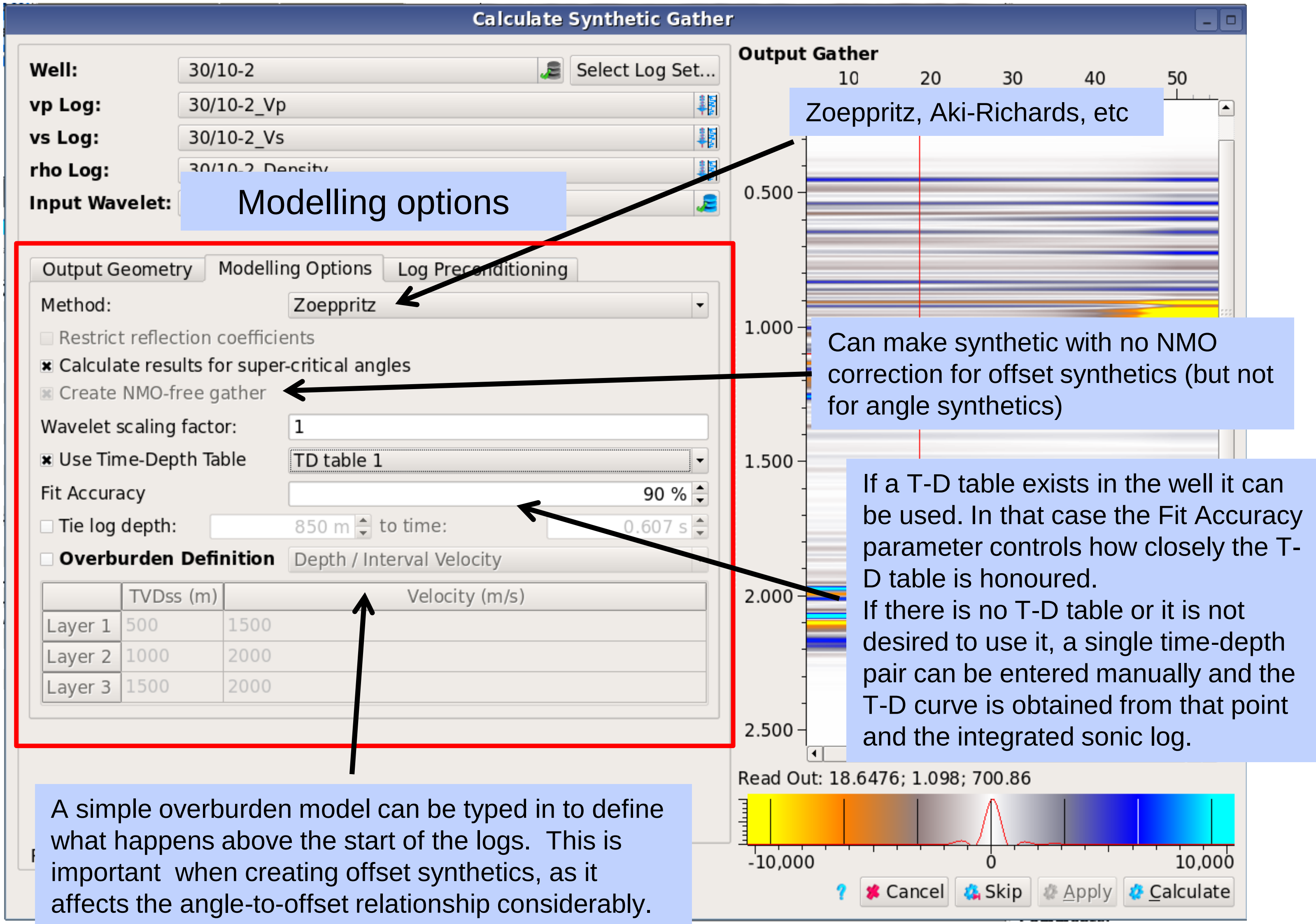
SYNTHETIC MODELLING

1D synthetic modelling

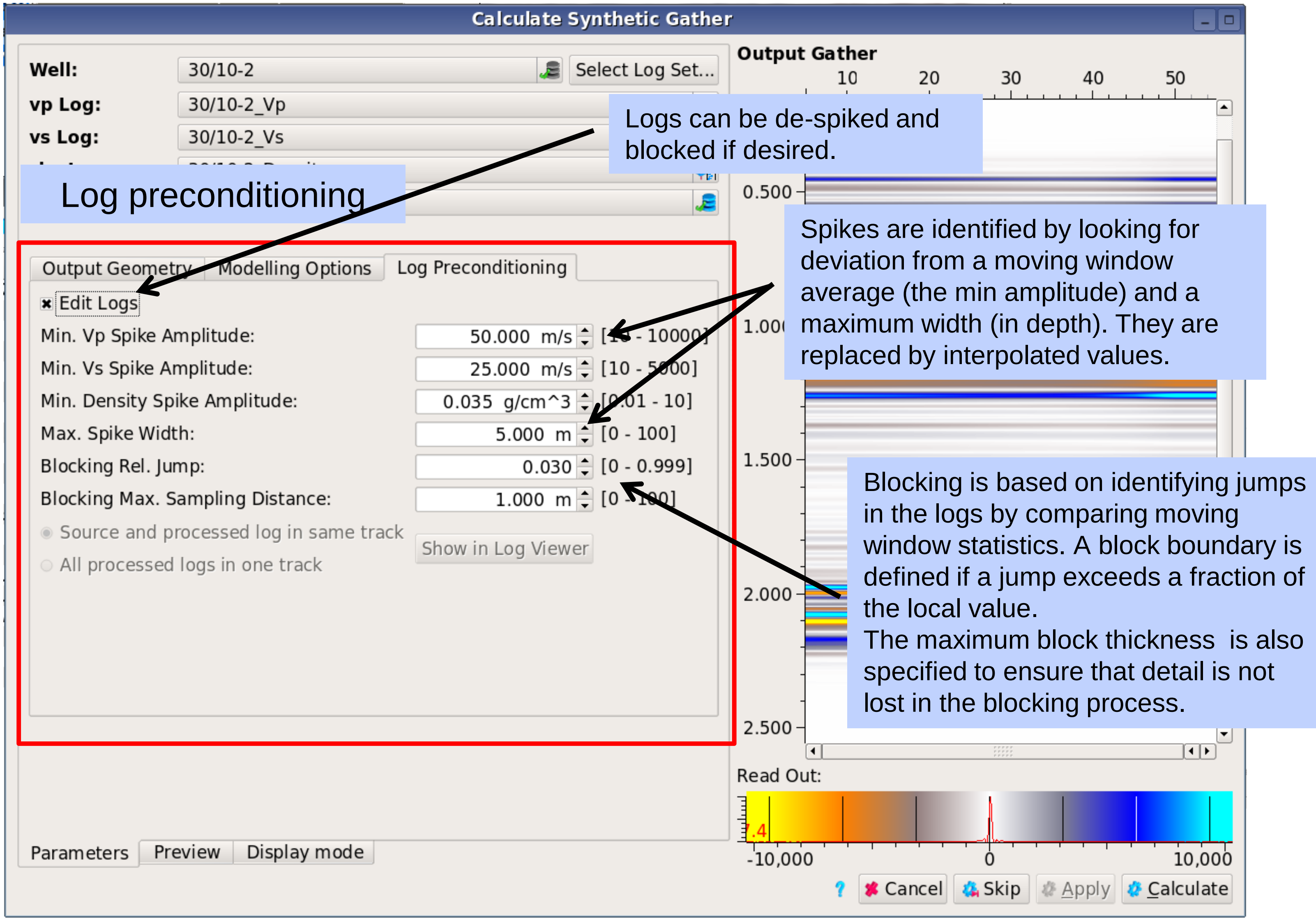
Interpretation-Processing > Generate synthetic gather ...



1D synthetic modelling



1D synthetic modelling



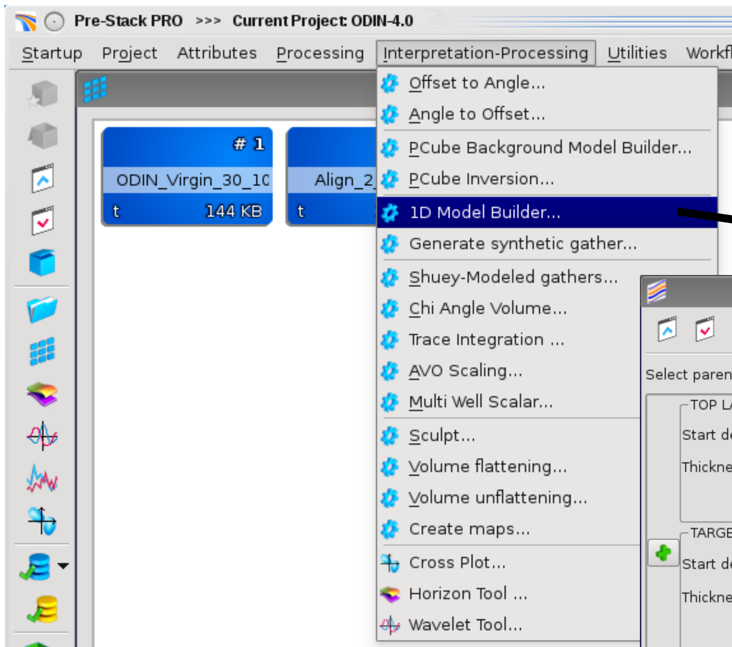
1D MODEL BUILDER

Introduction

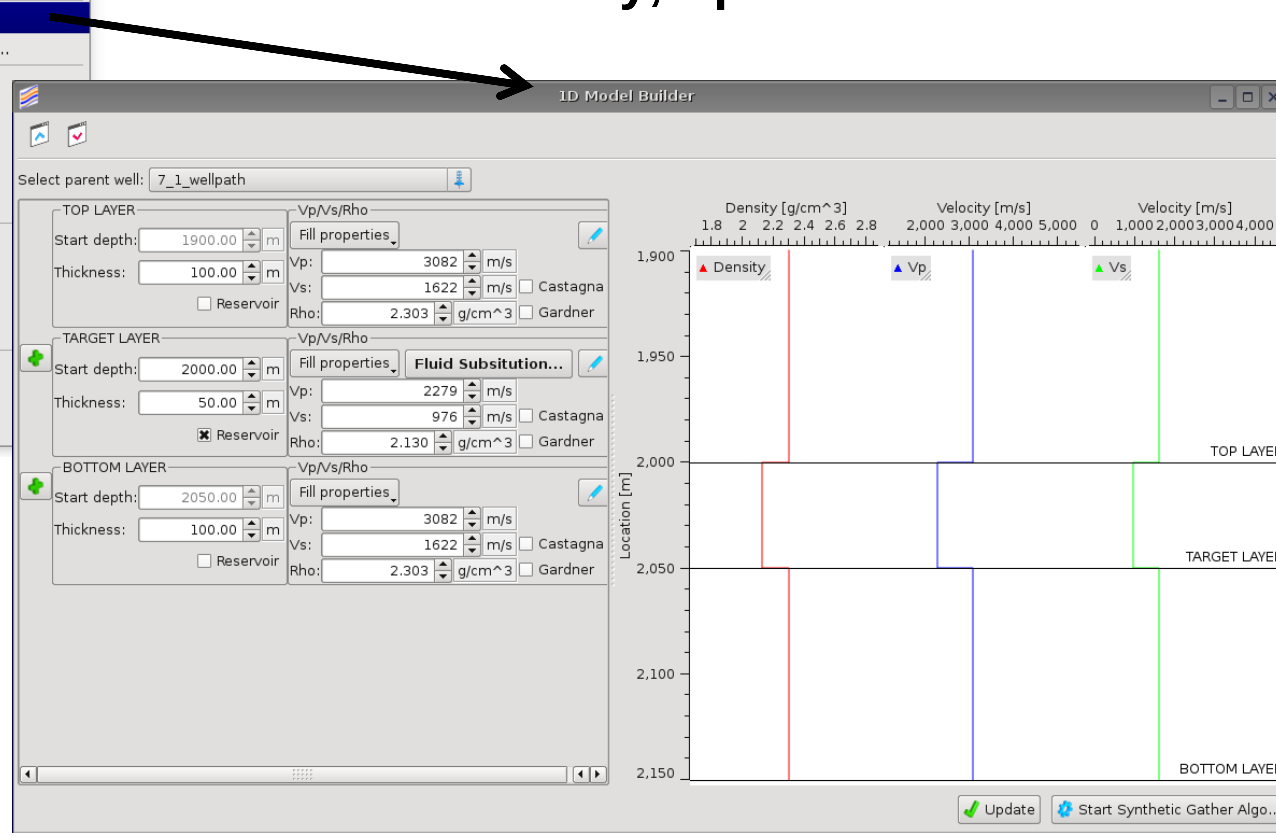
- New feature in version 4.4: **1D Model Builder**
- Creates 3 synthetic logs at any well, Vp, Vs and density
  (logs called .SynthModel_Vp, _Vs and _Rho)
- These logs are made from at least 3 user defined layers.
  (Top, Target and Bottom layers + any added inbetween)
- The Target layer has a fixed top MD, from which the model is built
- All the layers have a thickness to define their top / base from this
- Layer properties can be defined as follows -
- : Vp, Vs, Rho by manual entry of values,
- : Vs, Rho by Castagna and Gardner equations
- : Vp, Vs, Rho by well facies or zone, averages
- : Vp, Vs, Rho by «Reservoir» Castagna fluid substitution
- : Vp, Vs, Rho by «Reservoir» Gassmann fluid substitution
- A Synthetic gather is created using 'Start Synthetic Gather Algo..'
- Any model input log update, forces a redraw of this synthetic

Introduction

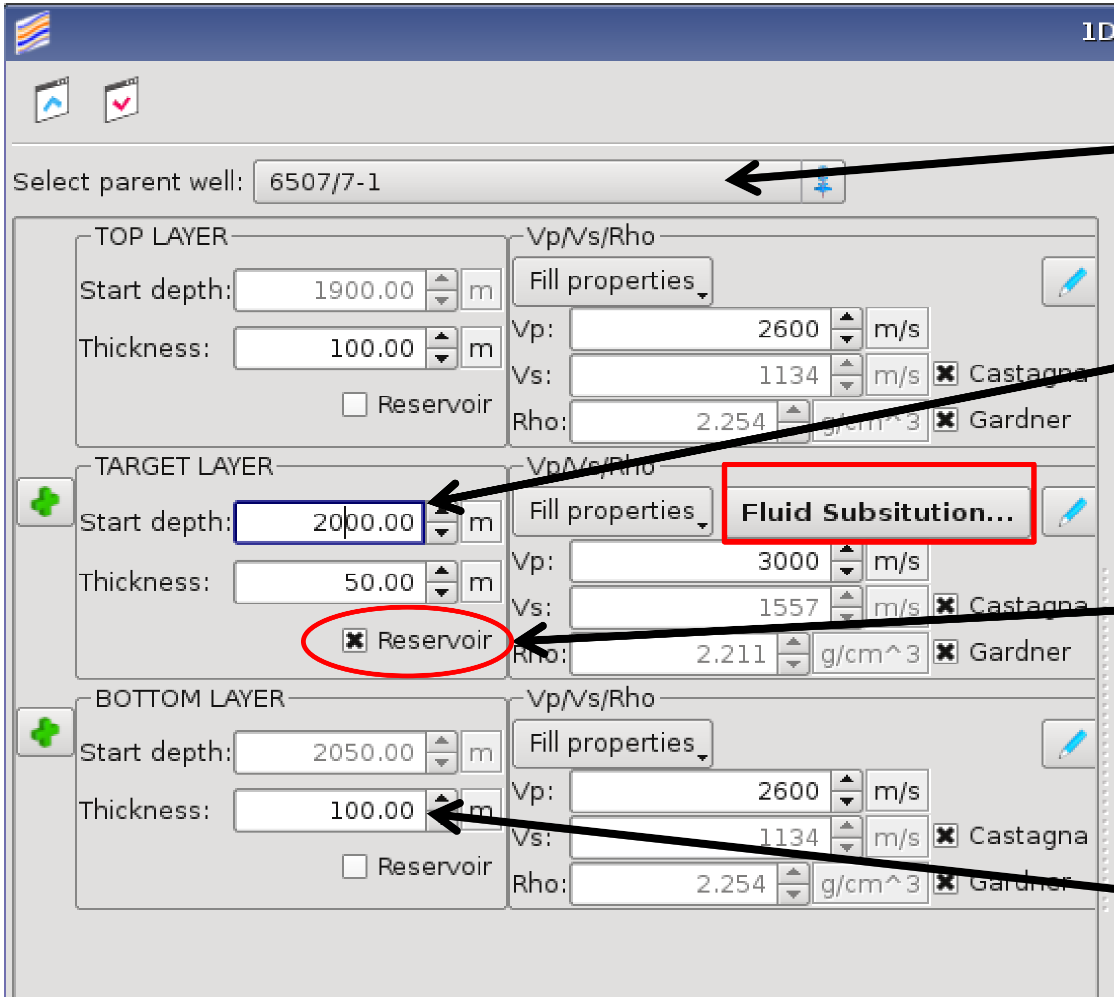
- **Interpretation Processing → 1D Model Builder**



- **New feature in version 4.4:**
- **Creates 3 synthetic logs at any well - Density, Vp and Vs**



Model setup



Select Well for log use/save

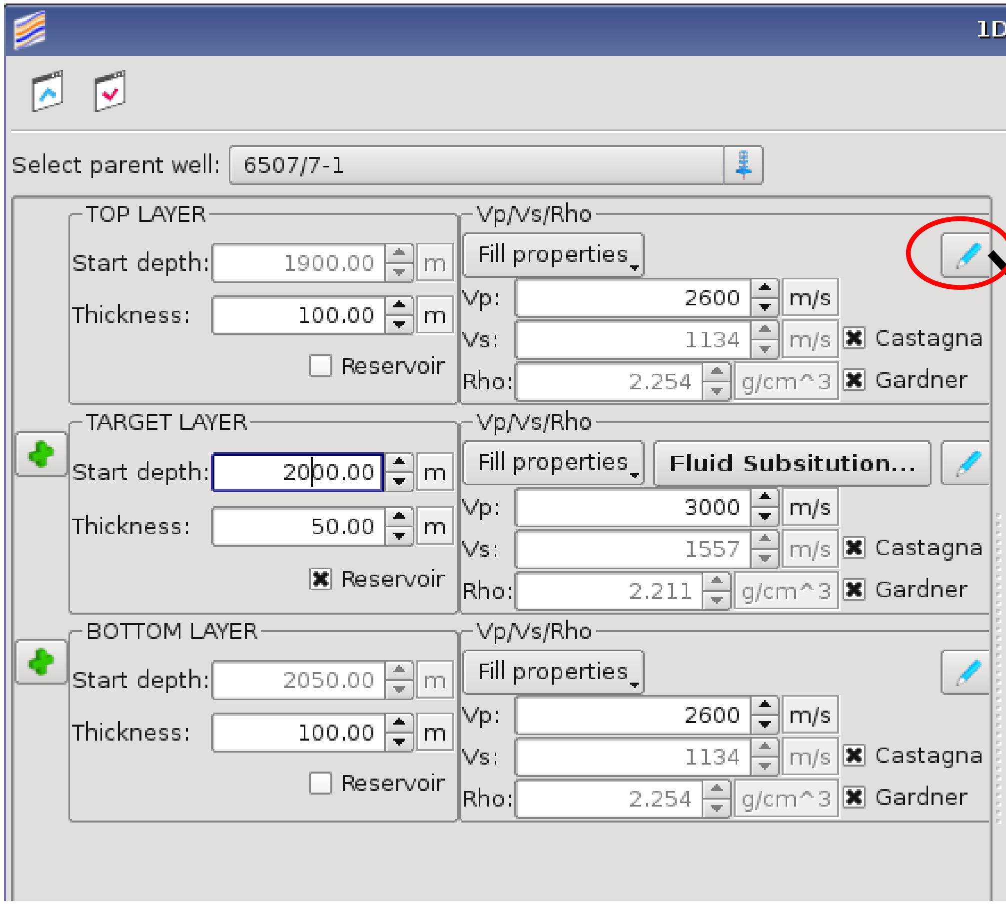
Enter Target layer top depth (MD) (2000 = model reference datum)

Choose which layers will be 'reservoir' and have fluid substitution options

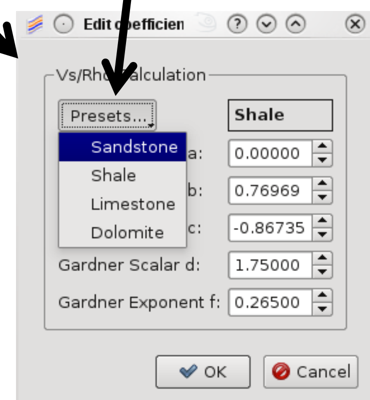
Enter layer thickness in m

Layer properties definition

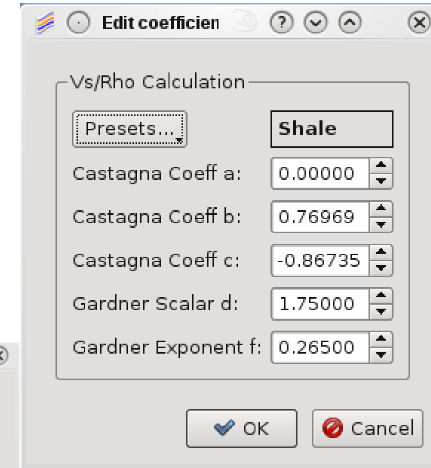
- **Vs, Density coefficient selection**



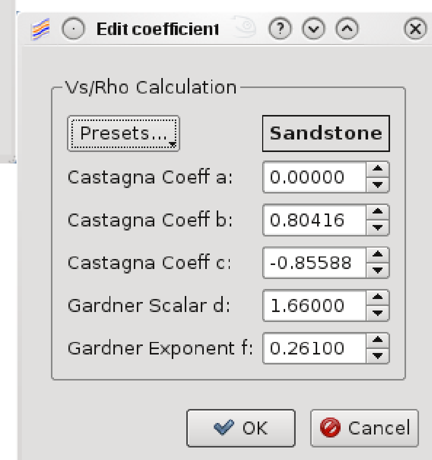
Select Preset lithology or enter values into coefficient boxes



Shale coeffs



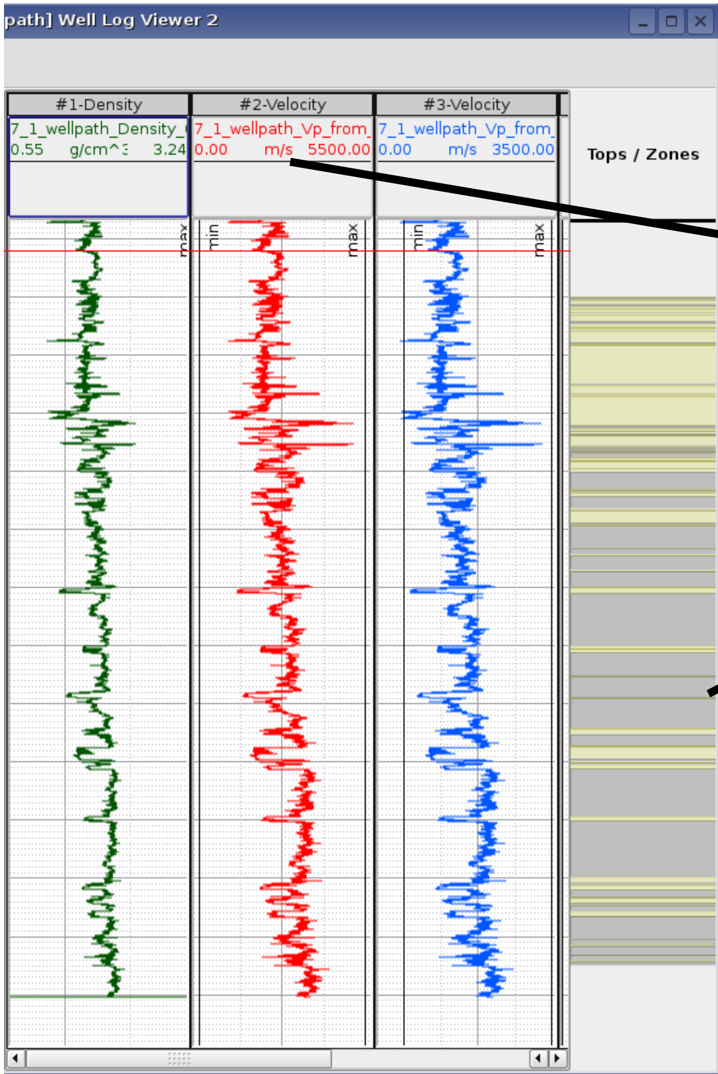
Sandstone coeffs



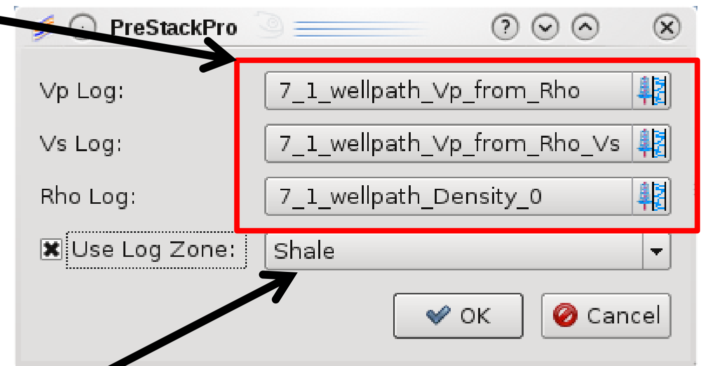
Layer properties definition

- **Vp, Vs, Density facies/zone averages 1**

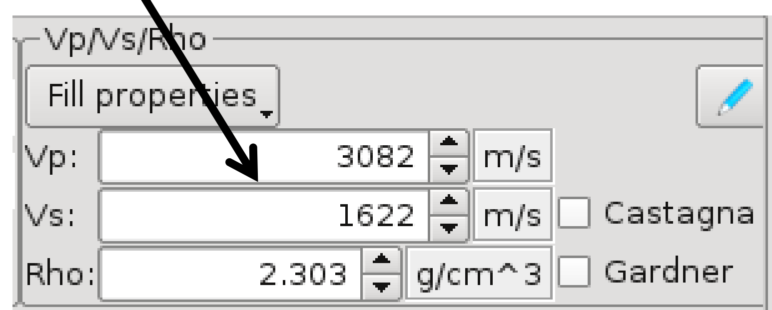
Zones created in Well Log Viewer, can be used to calculate an average Vp, Vs, Rho - in this case for Shale





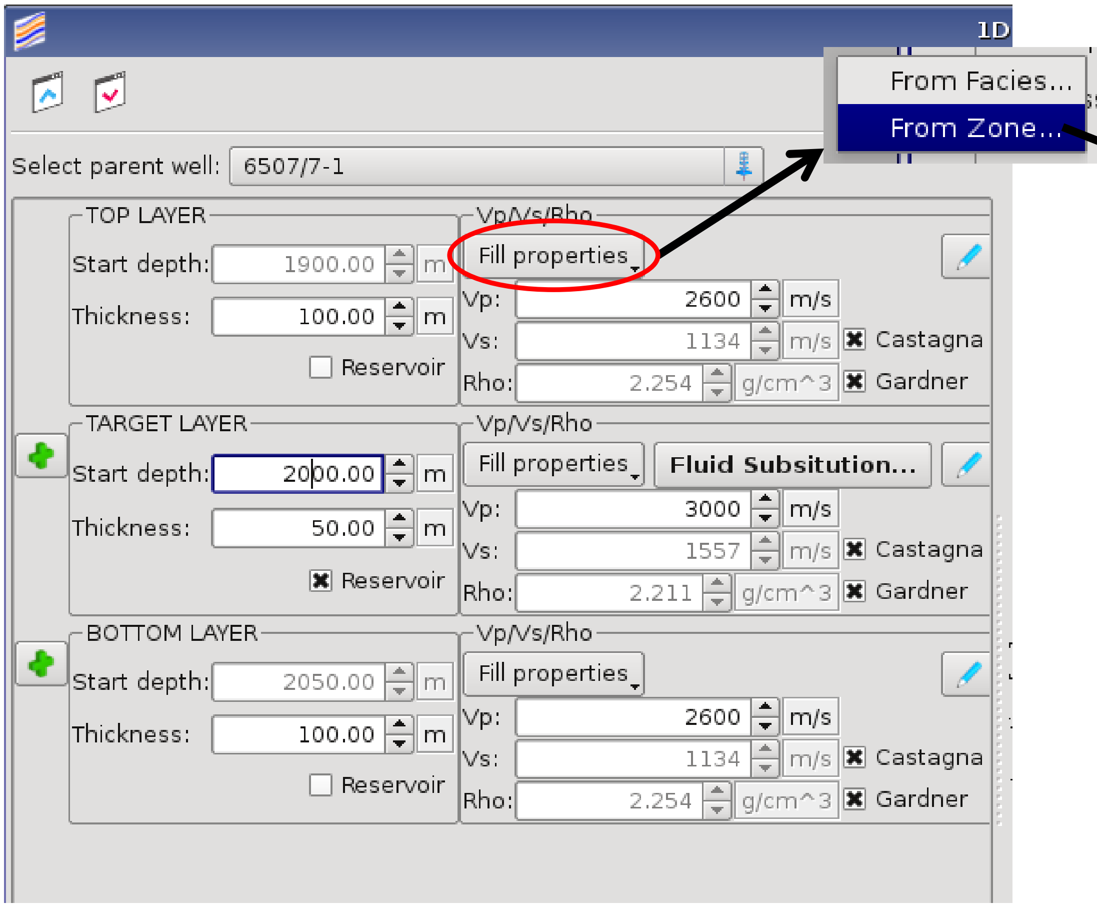


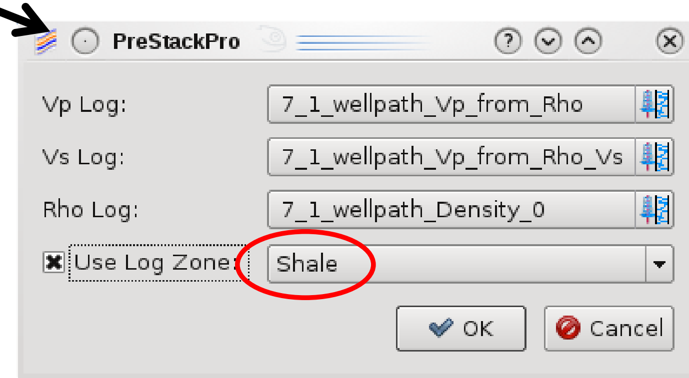
Shale zone Vp, Vs Rho averages



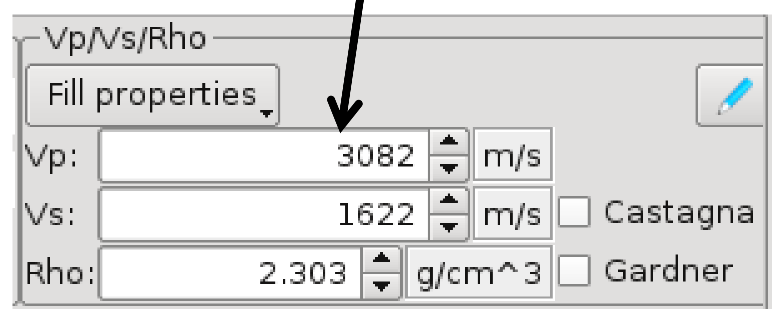
Layer properties definition

- **Vp, Vs, Density facies/zone averages 2**



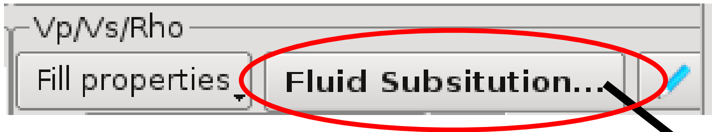


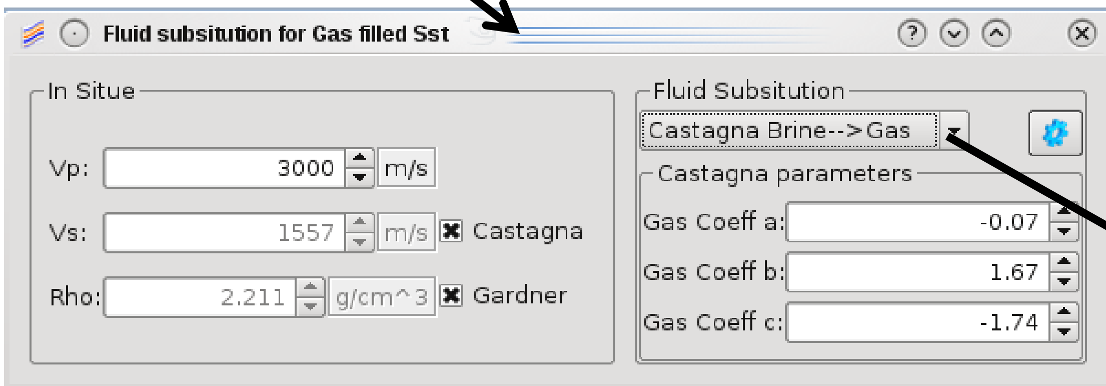
Shale zone Vp, Vs Rho averages

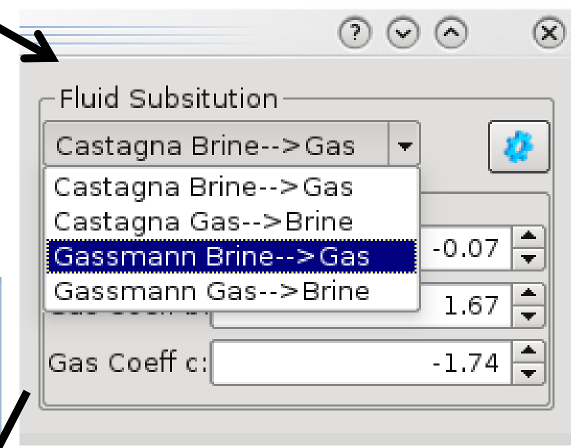


Layer properties definition

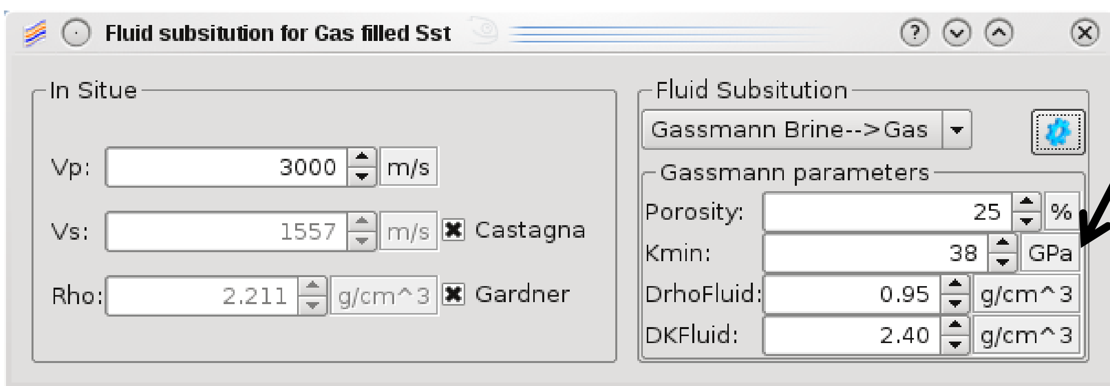
- **Vp, Vs, Rho, from fluid substitution – reservoir layers only**







Castagna equation – consolidated sands

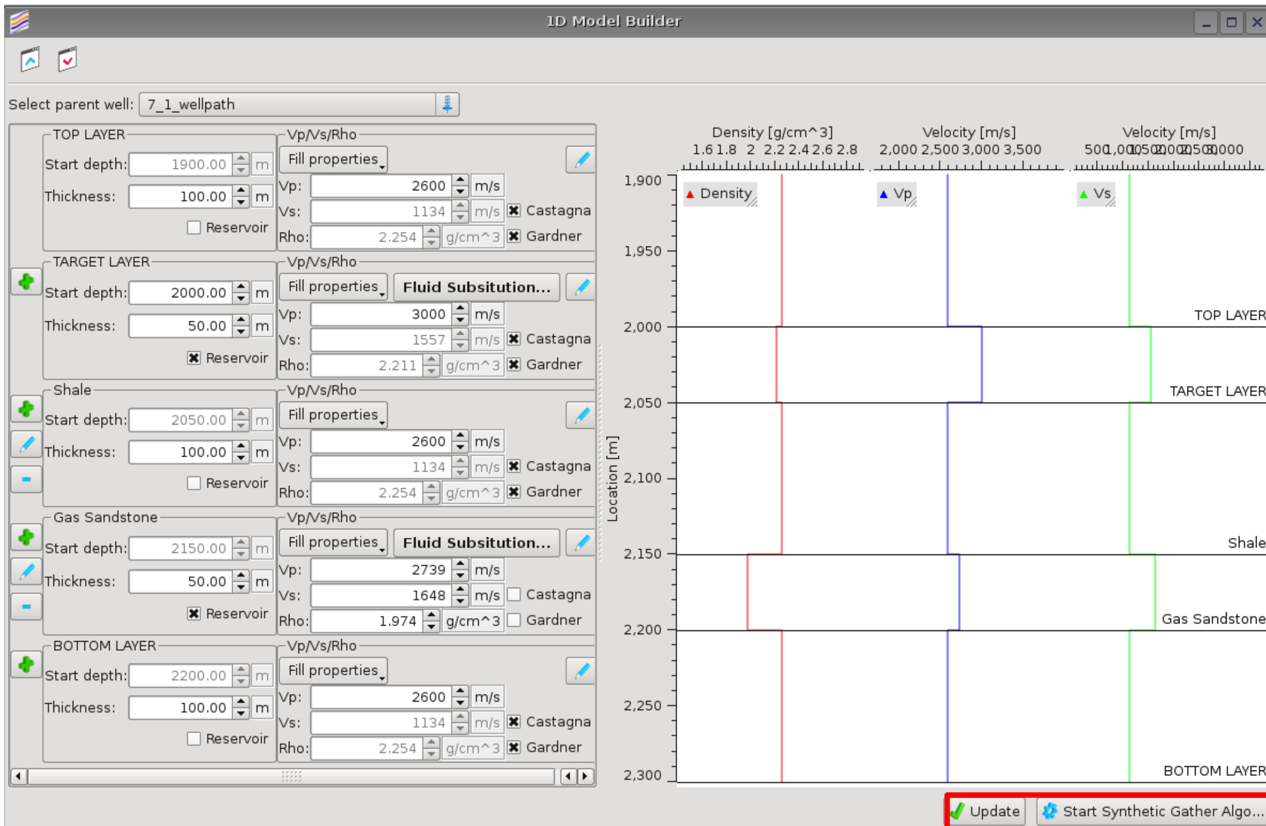


Gassmann equation – soft sands

Final 5 layer model

- **Example from Fred Hilterman's 2001 SEG DISC book : Seismic amplitude interpretation - 9000ft GOM AVO**

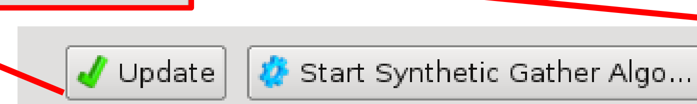
Shale Vp = 2600 m/s, Sst (Brine) Vp = 3000 m/s, Vs & Rho from equations



Brine filled Sand

Gas filled Sand

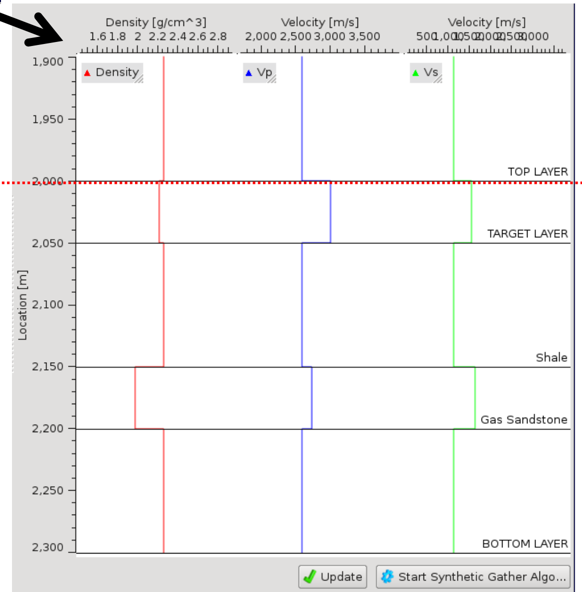
Calculated by Gassmann fluid sub, Φ = 25%



Calculate synthetic gather

- **Angle gather -** **with bpass wavelet 5-15-45-55**





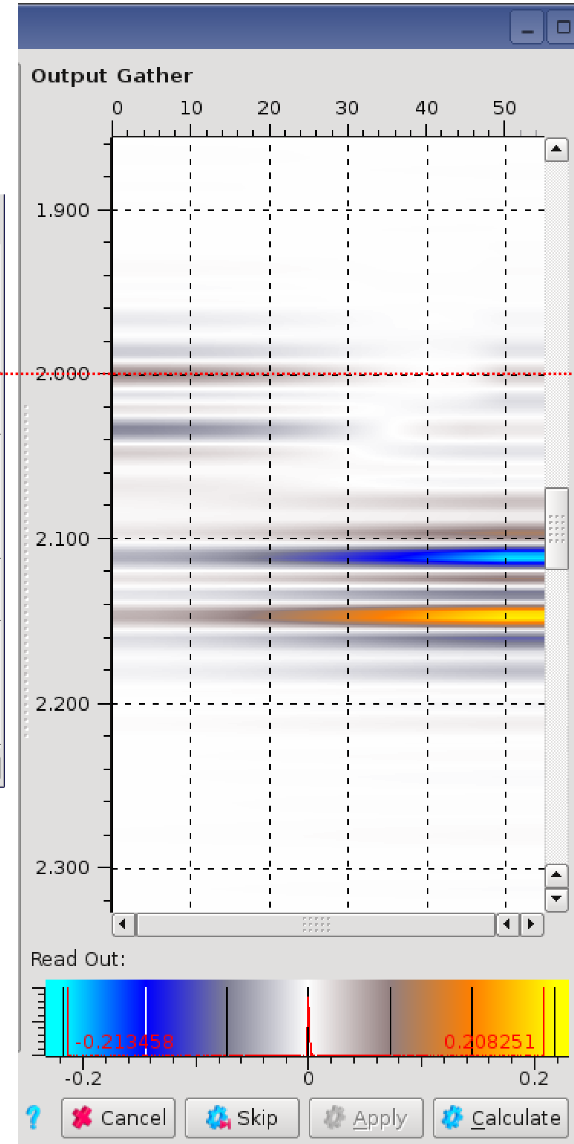
Click on «Start Synthetic Gather algo» takes the model logs and creates a gather synthetic.

The wavelet applied comes from the project wavelet list.

Use the «Tie log depth» modelling option to ensure the synthetic Target layer top is at the right TWT.

(MD = TVDss = 2000m = 2.0secs)





View results in Data Comparator

Data Comparator allows wiggle trace display

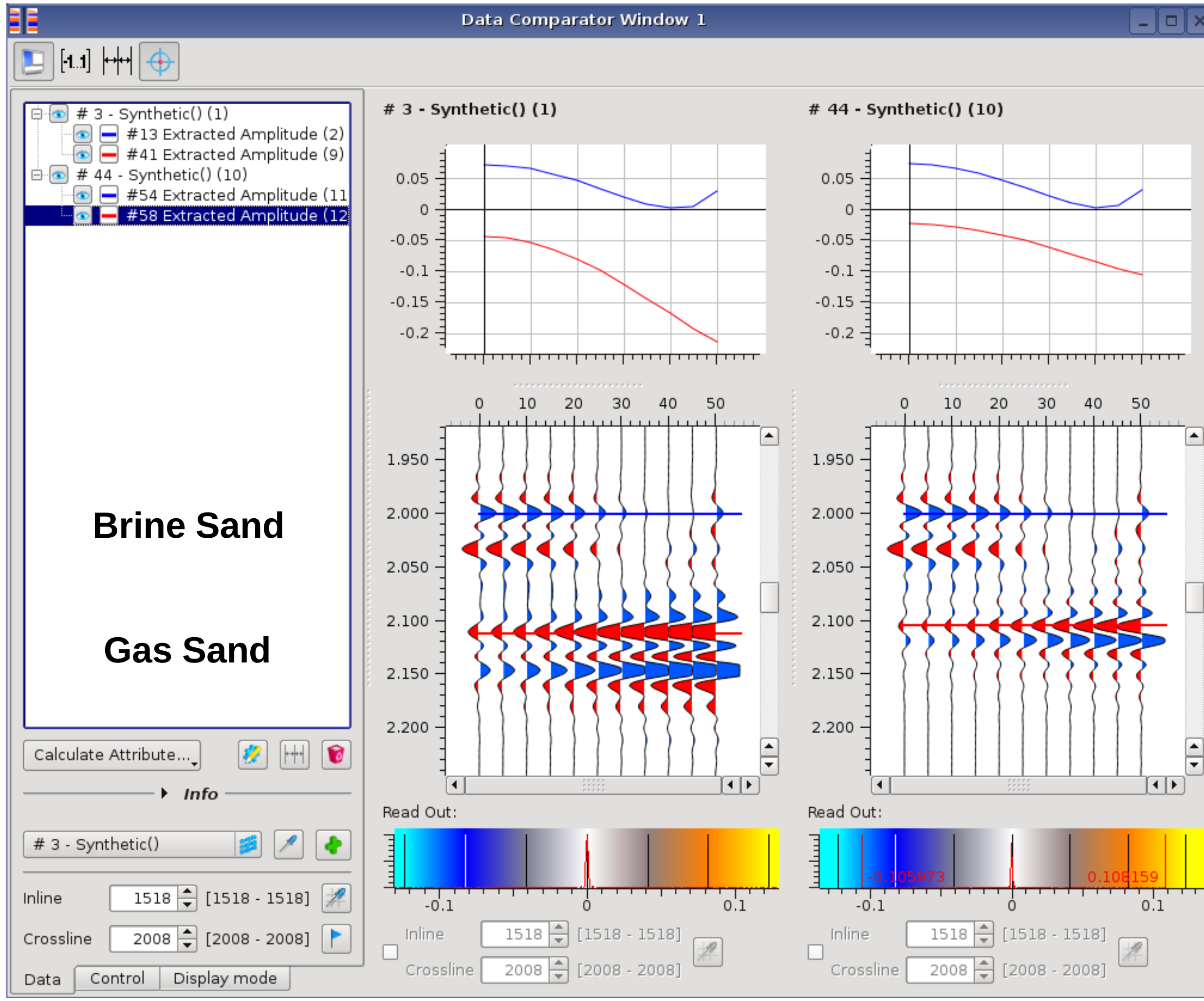
Also amplitude extractions can be made for the brine and gas cases and visually compared in the plots above the gathers.

(blue = brine, red = gas)

The first gather is with a 50m gas reservoir thickness

The 2nd with only 10m

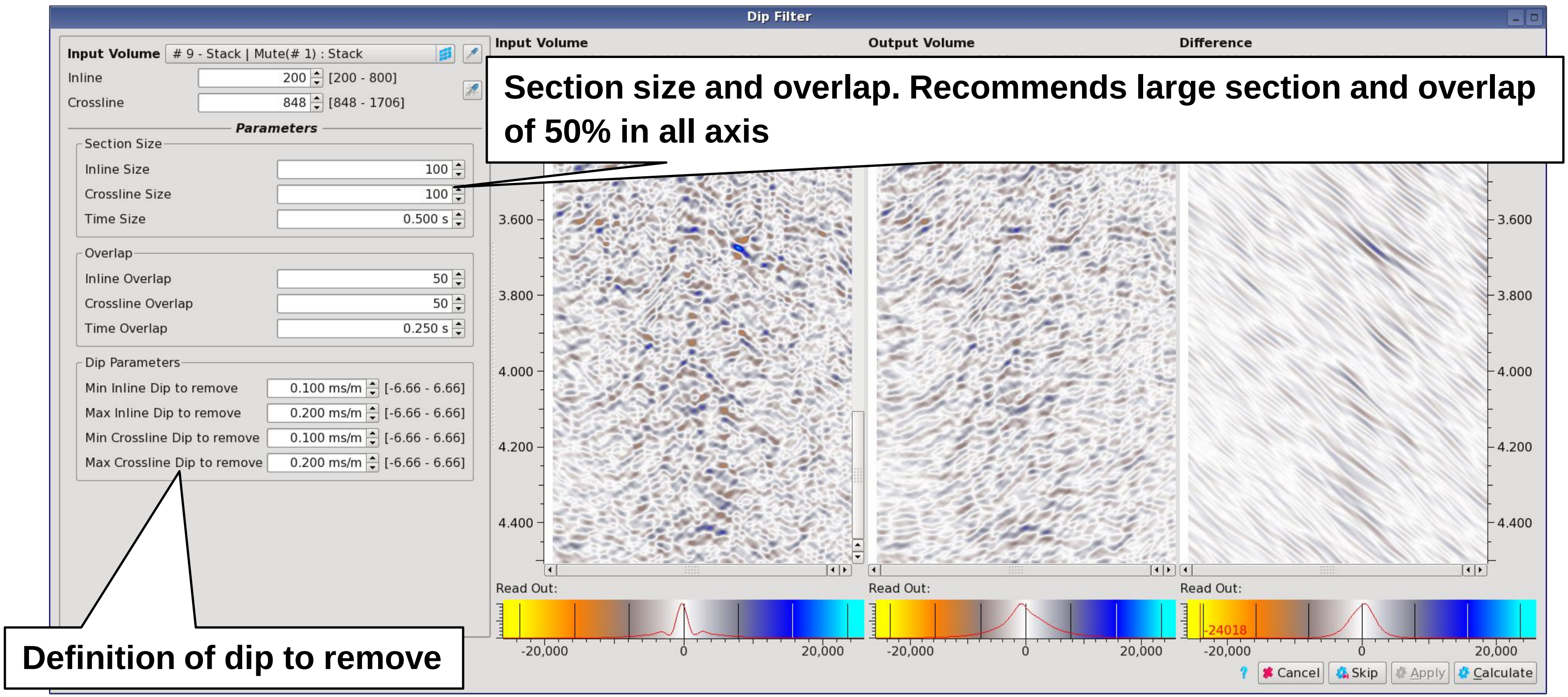
The thinning of the layer has dimmed the AVO response but it stays opposite in polarity



PROCESSING

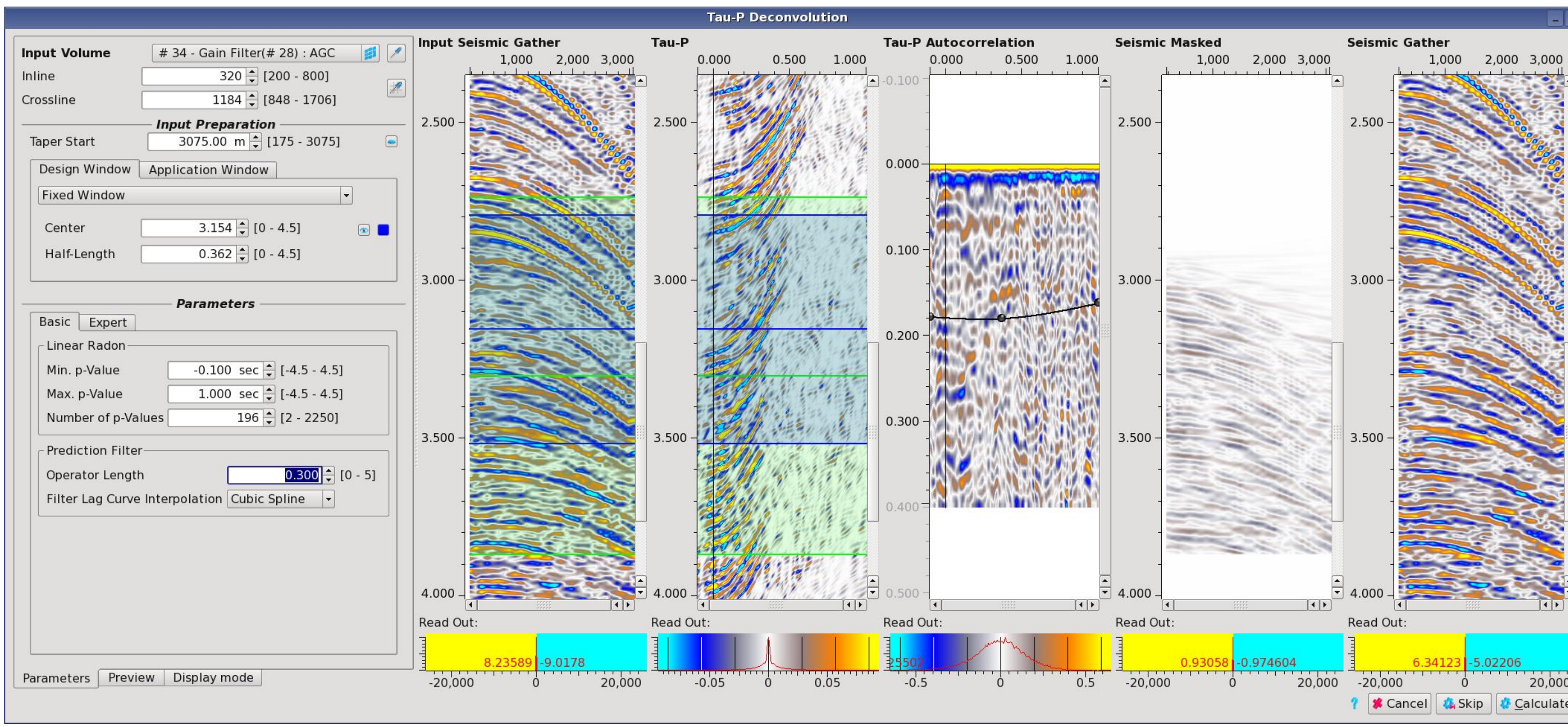
Dip Filter

- **Processing → Dip Filter**
- **Attenuate given dips on pre-stack volume in the offset class domain or post-stack**

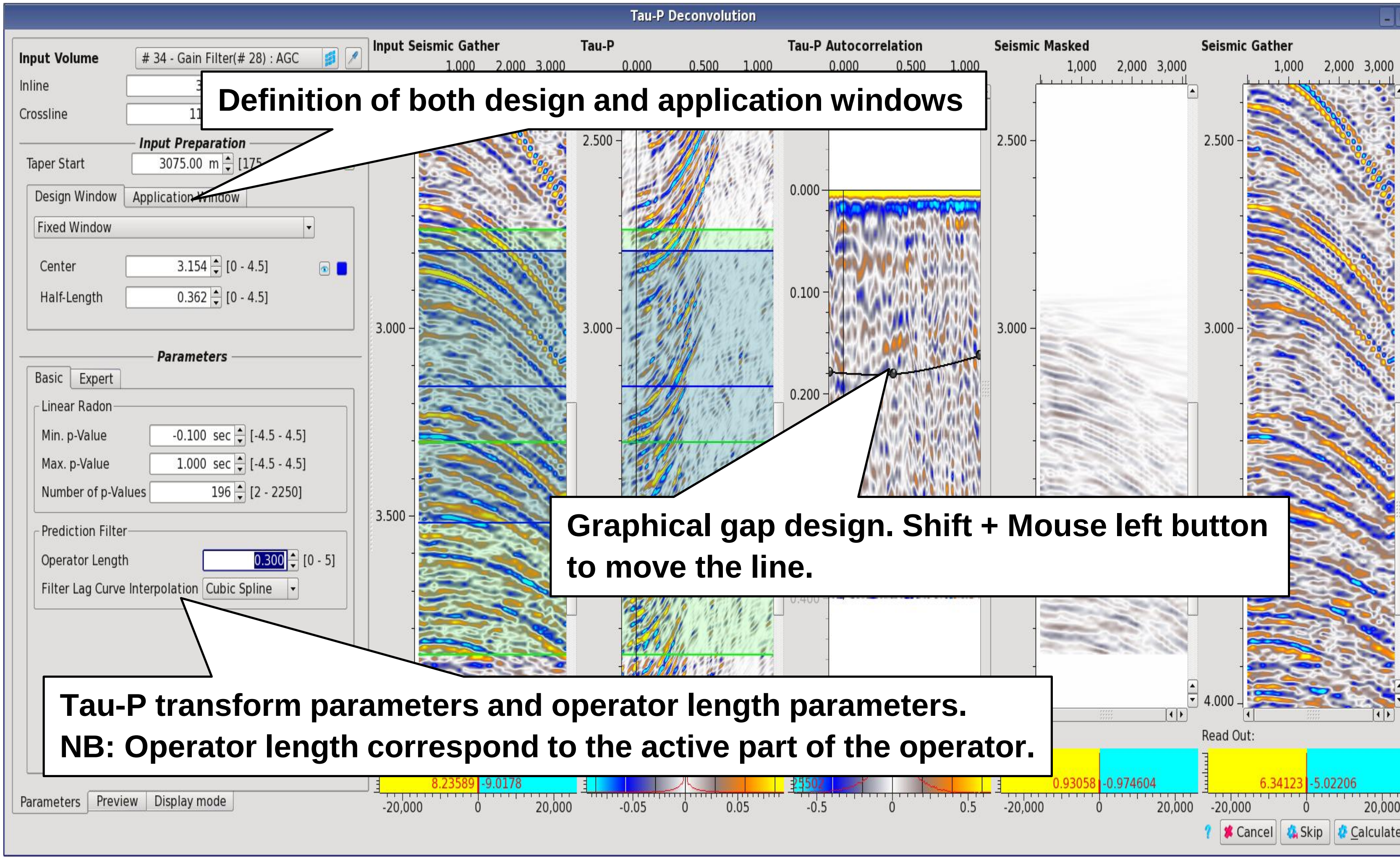


Tau-P deconvolution

- **Processing → Tau-P deconvolution**
- **Predictive gaped deconvolution in Tau-P domain. Targets short period multiples. Input is non NMO corrected gathers**

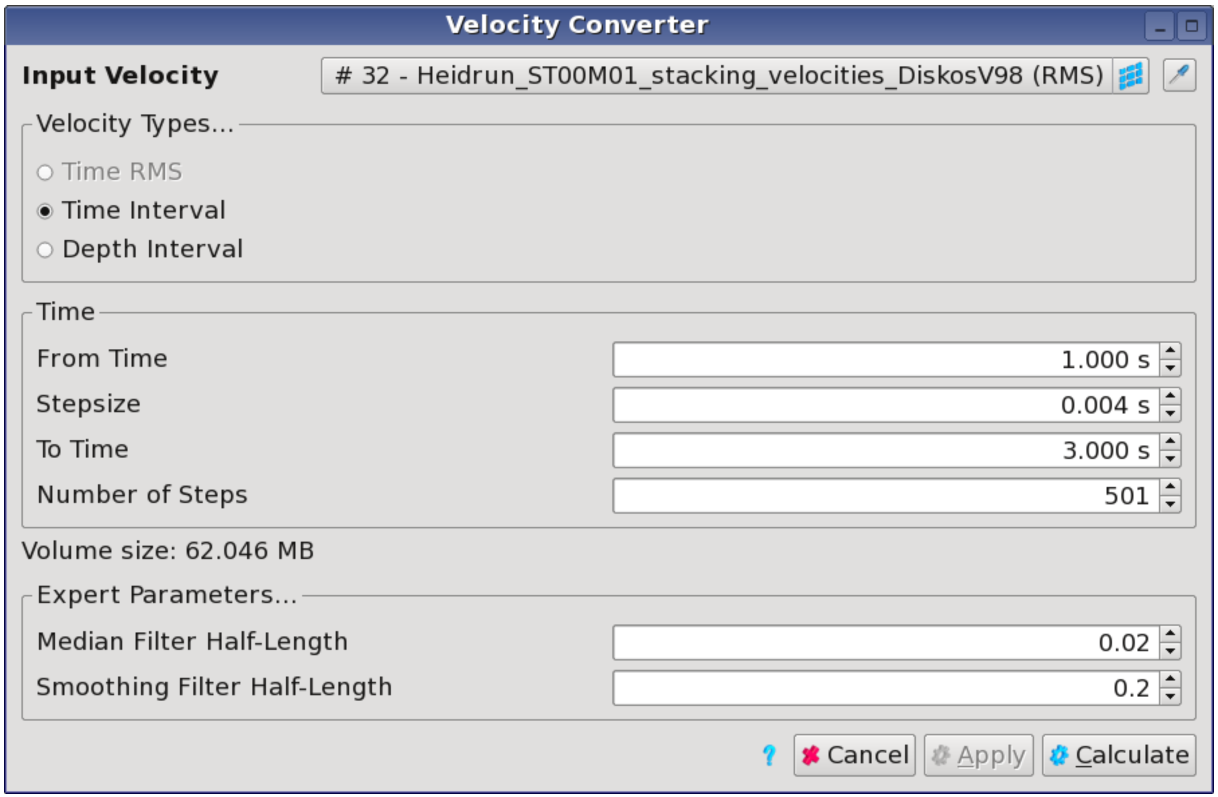


Tau-P deconvolution



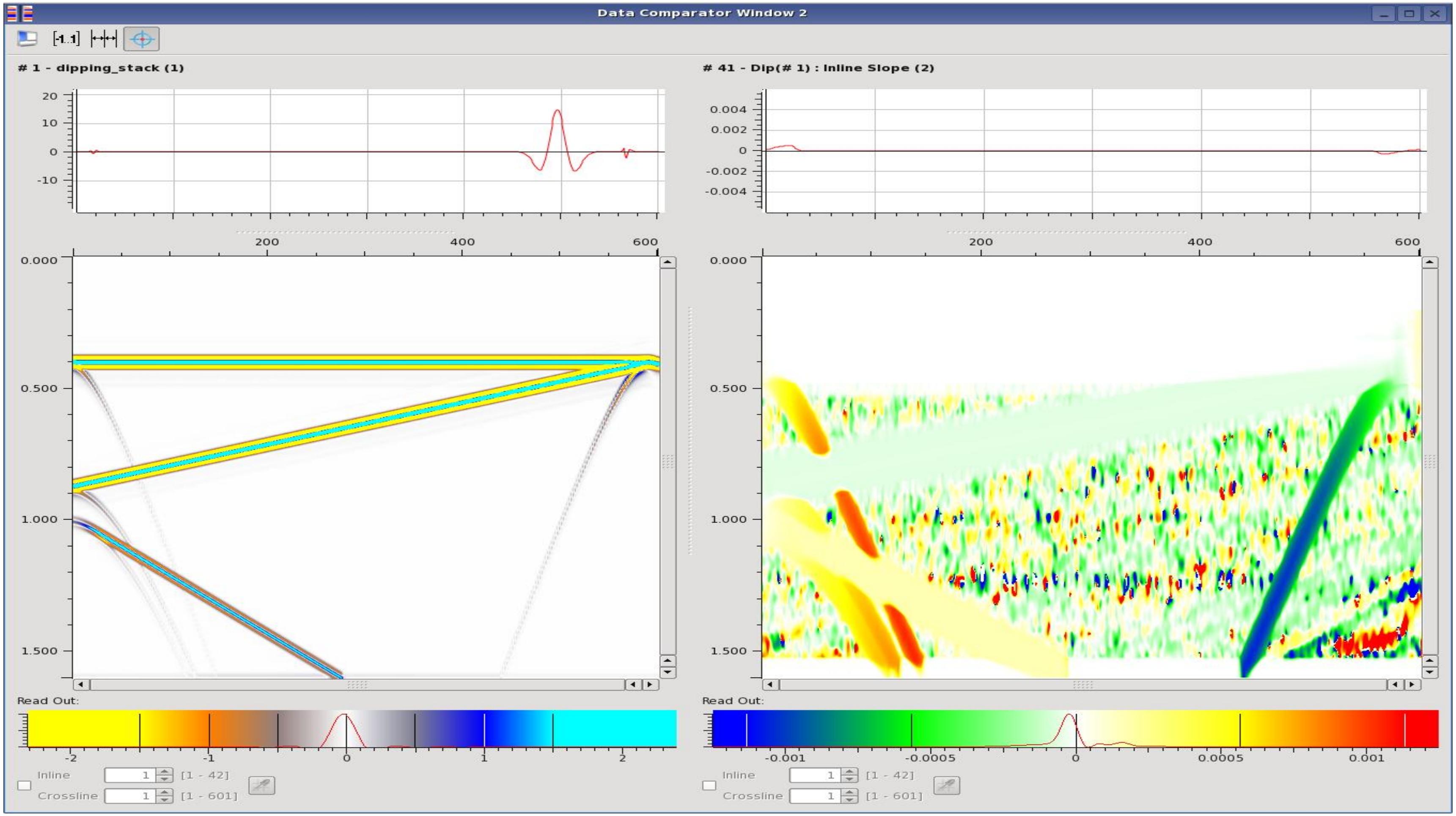
Velocity converter

- Processing → Velocity converter
- Input a velocity volume and convert to Interval/RMS on the fly.



NEW ATTRIBUTES

Dip-Steered Semblance



Stack with dipping events and its inline slope attribute

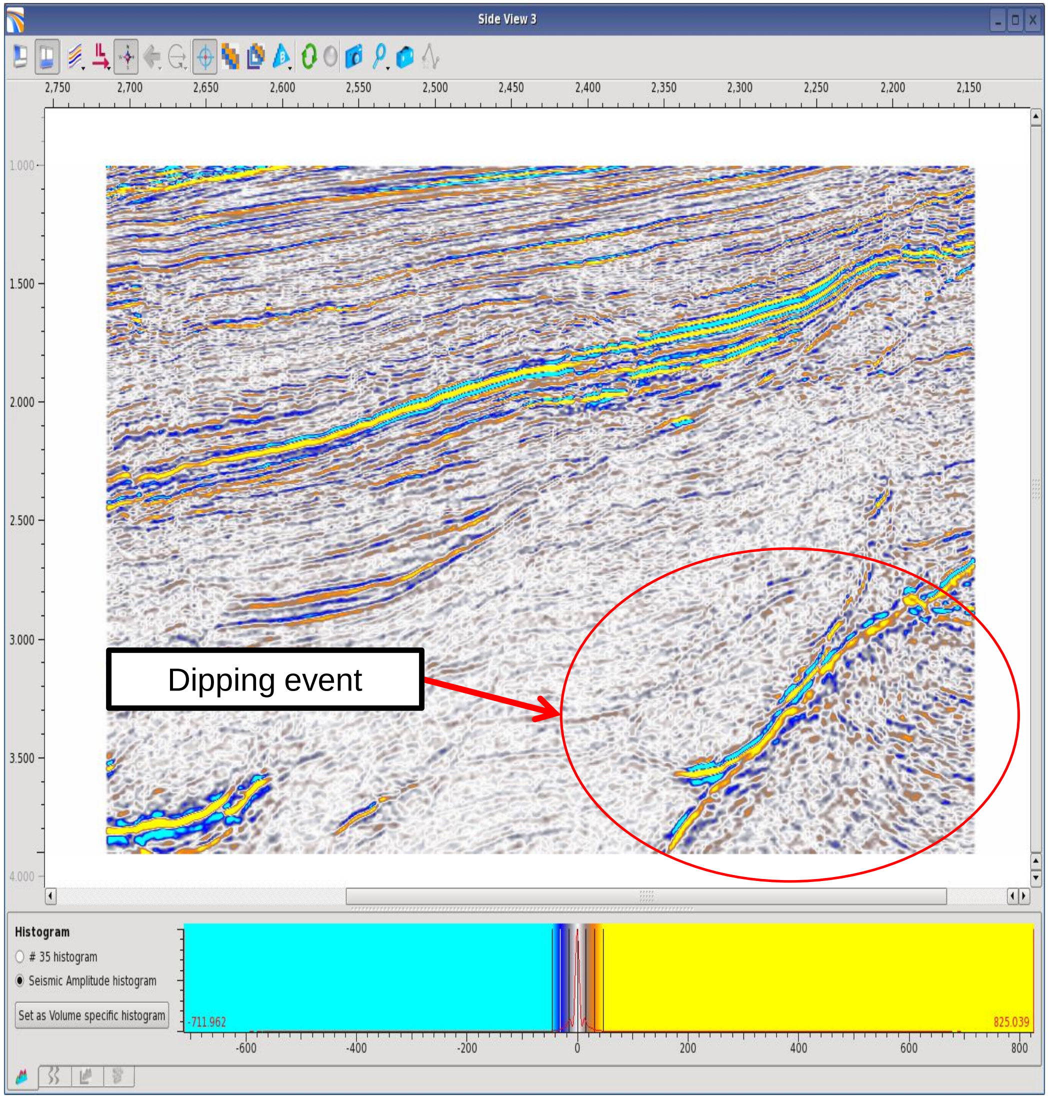
Dip-Steered Semblance

- Go to Attributes -> Dip-steered semblance

- The algorithm takes as input a seismic volume and its inline and crossline slopes computed per offset classes.

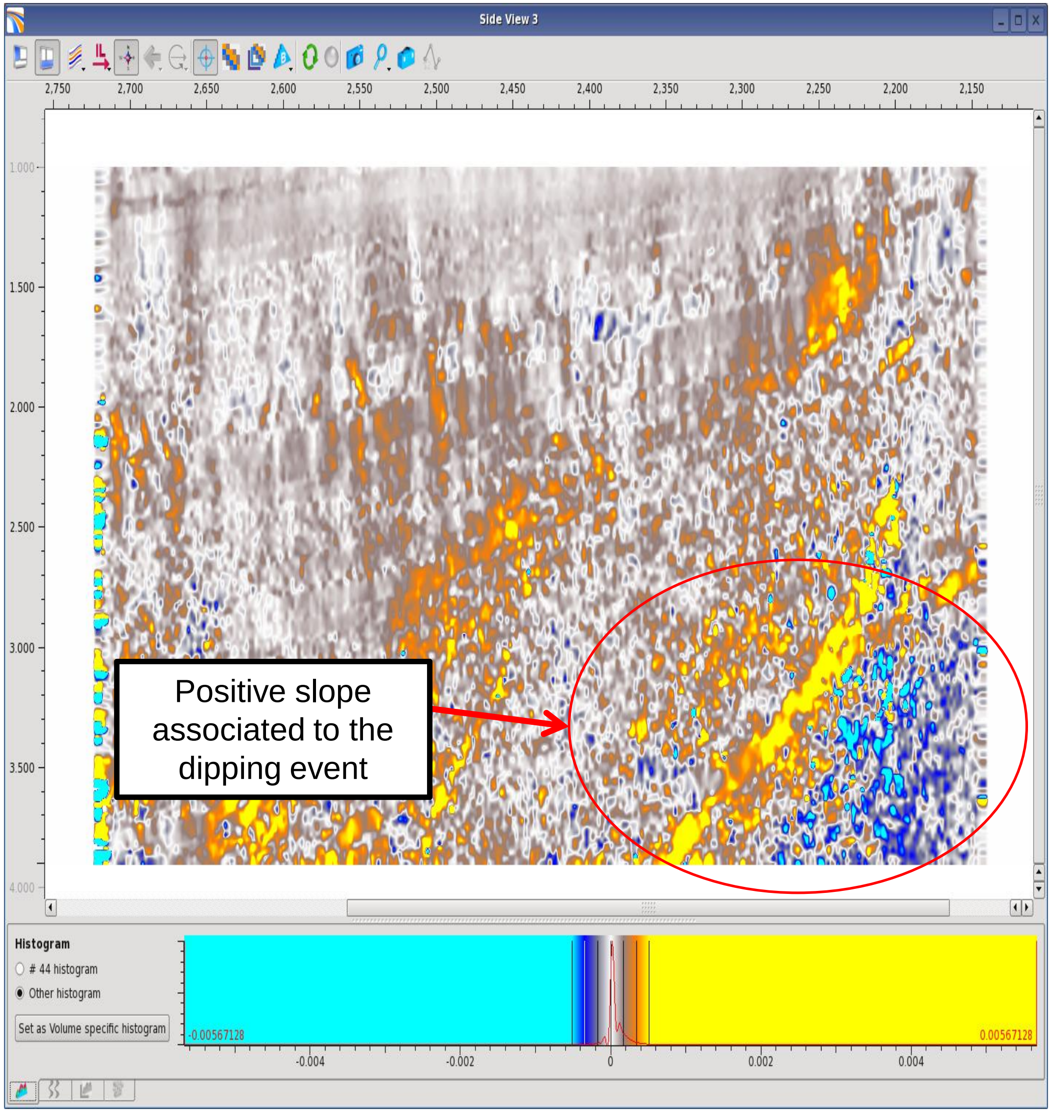
- Semblance is a measure of the coherence of seismic data and is equal to the energy of a stacked trace divided by the energy of all the traces that make up the stack. The stencil within which the semblance is computed will use the inline and crossline slopes to follow dipping events, resulting in a better estimation of the signal coherency for structures with large dips than with conventional vertical moving windows.

Dip-Steered Semblance



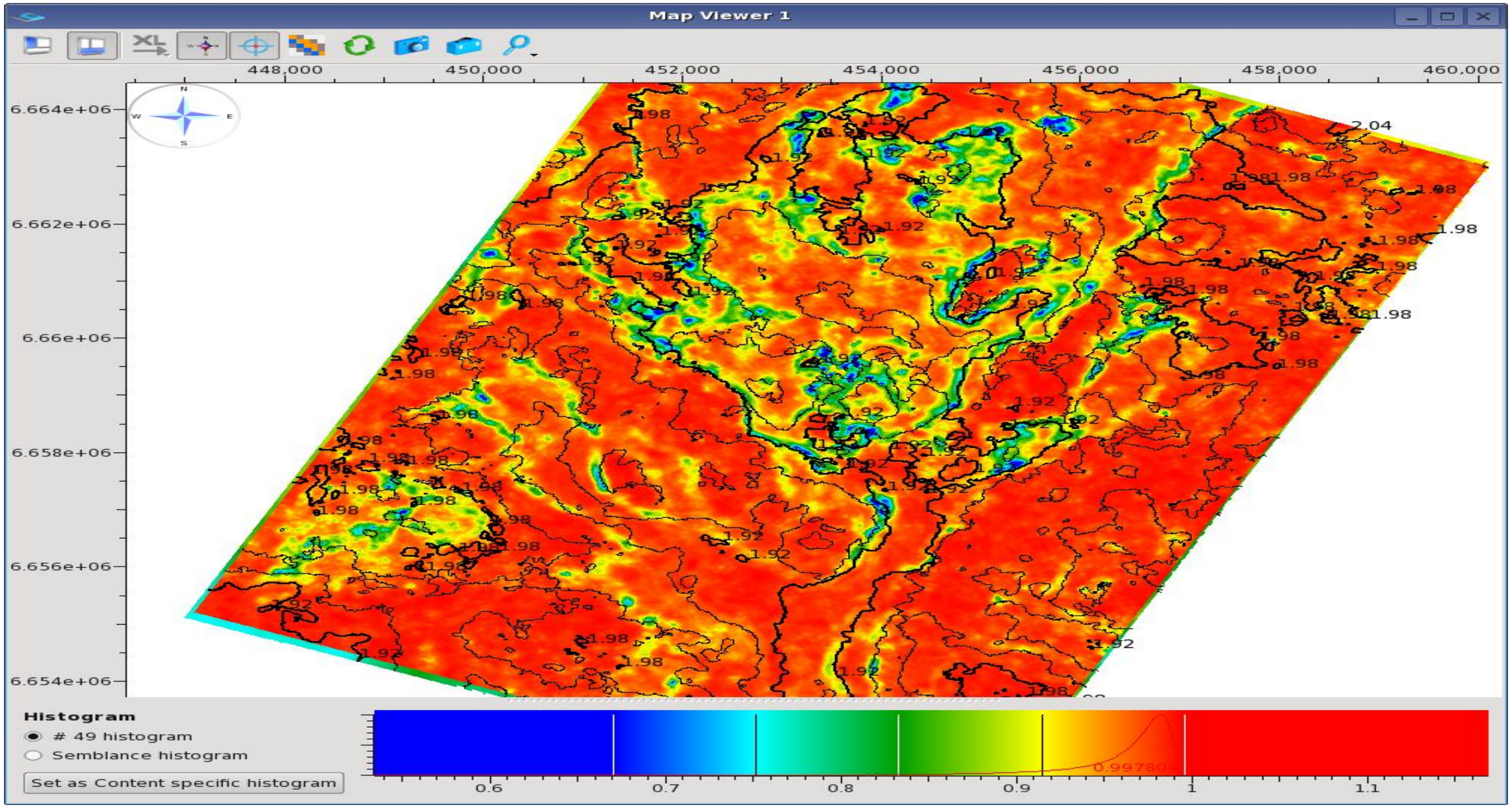
- Slopes can be calculated with Attributes -> Structural Dip
- For time domain data the slopes will be measured in slowness along the inline and crossline direction
- This attributes are derived from the second-moment matrix of the seismic that involves the computation of the gradient in a stencil

Dip-Steered Semblance



- The user has to specify 2 parameters for slope calculation
- Noise scale: defines the resolution of the filter.
- Integration scale: gives a trade of between edge-enhancing diffusion and coherency enhancing diffusion behavior

Signal to Noise Ratio



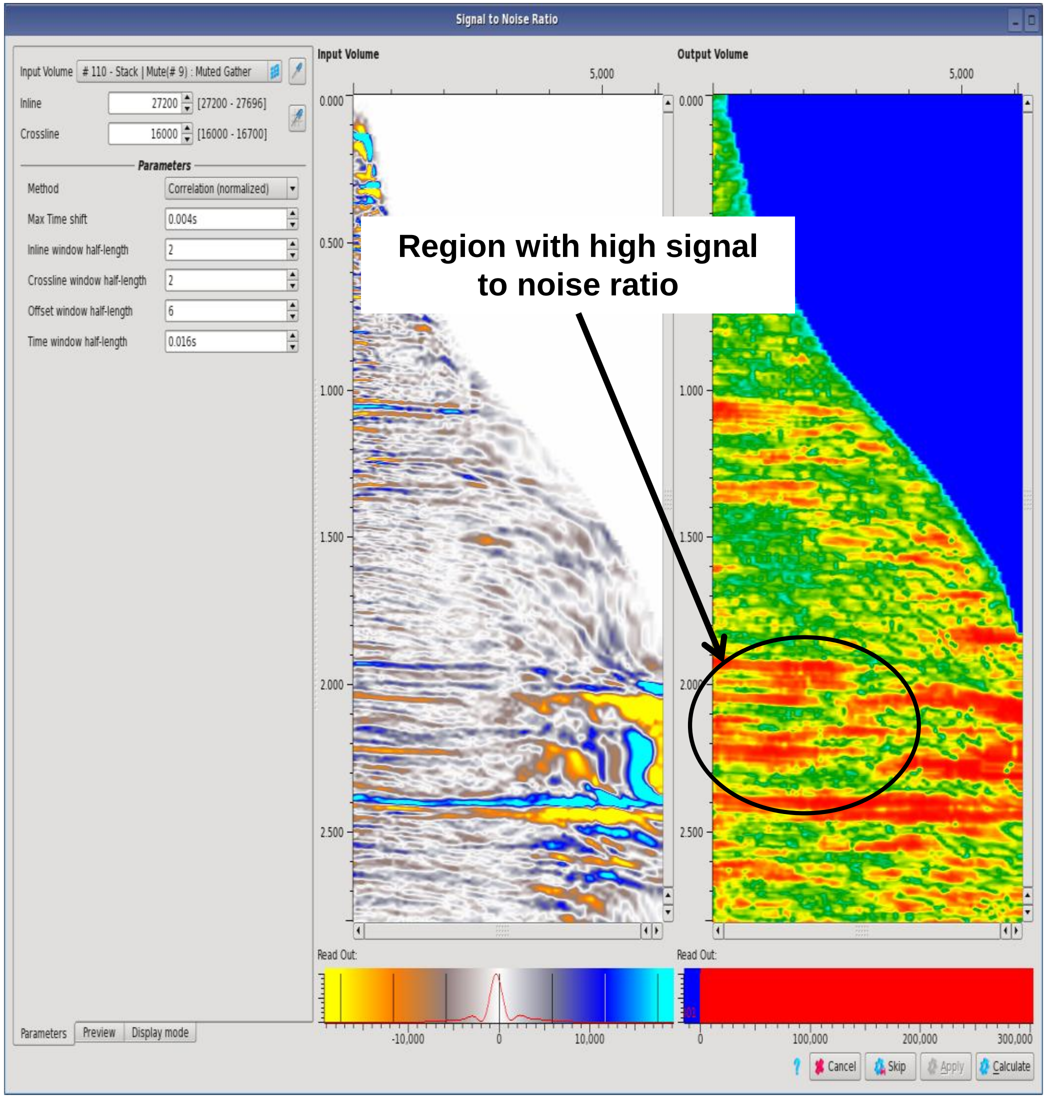
Signal to Noise Ratio extracted at top reservoir

Signal to Noise Ratio

- Go to Attributes -> Signal to Noise Ratio

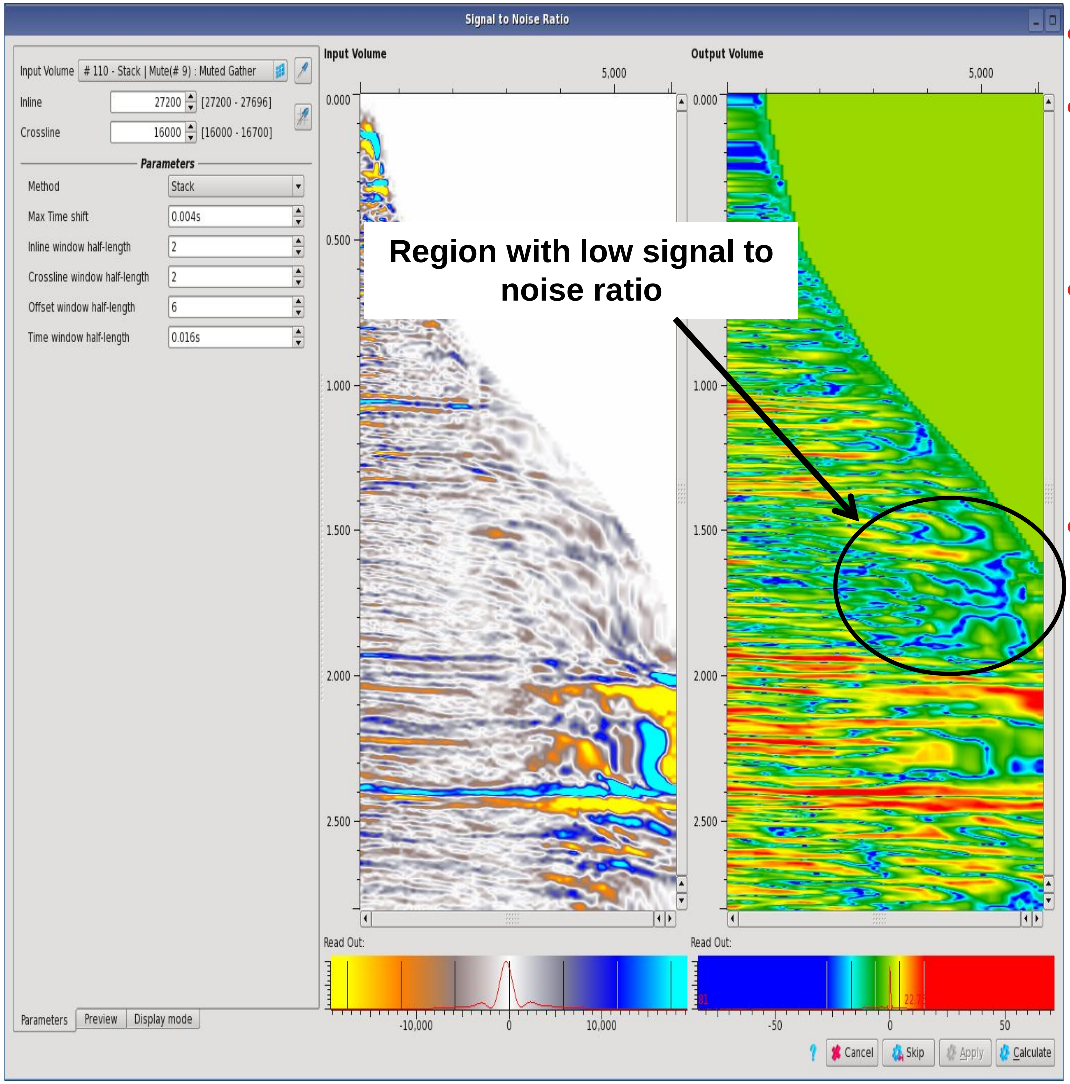
- S2N is defined as the ratio between the signal power to the noise power. Two methods have been implemented to estimate this measure. A **correlation method** based on the assumption that the form and phase of the signal is consistent across neighbor traces and that the noise is spatially incoherent and uncorrelated to the signal. The **stack method** makes the assumption that the seismic wavelet is stable in a given spatial window and that the noise is white.

Signal to Noise Ratio



- Correlation method
- The user specifies the size of the stencil (in space and time) and the maximum time shift which corresponds to the half-length of the correlation window
- Xc = average correlation coefficient between central and neighbors traces
- Ac = auto-correlation coefficient of the central trace
- S2N = Xc/(Ac-Xc)

Signal to Noise Ratio



- Stack method
- The user specifies the size of the stencil (in space and time)
- Since the noise is assumed to be white its spatial average value inside the stencil is zero
- Therefore the energy of the signal is the spatial some of the square of the stacked trace and the energy of the noise is the total energy minus the energy of the signal

Geometric Properties

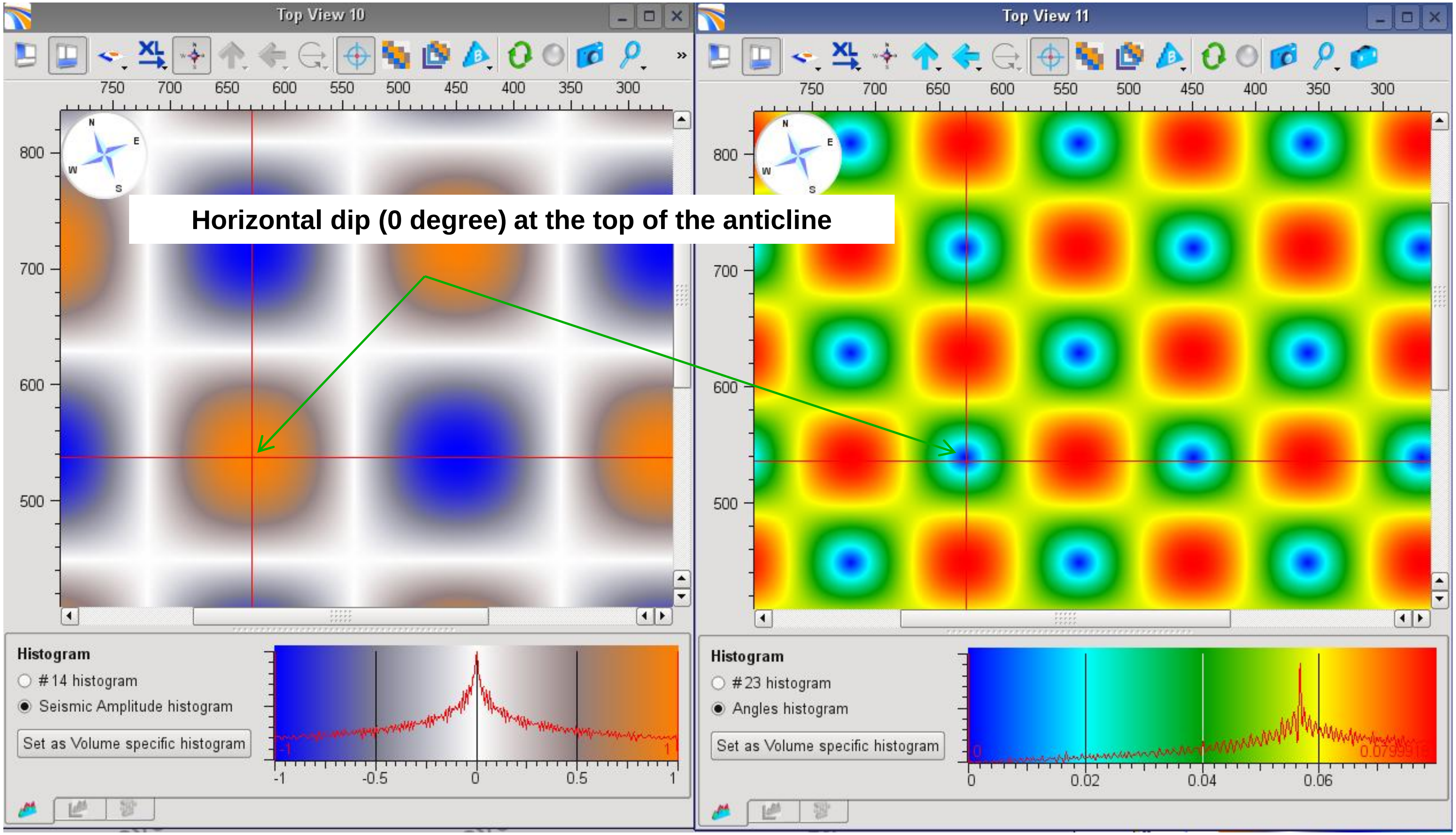
- Go to Attributes -> Geometric Properties

- Input has to be an horizon or a stack volume (in this case the computation will be done for every time slices)

- Curvature attributes are calculated by locally fitting (in a least-square sense) a second order 2D polynomial to the input horizon

- Outputs will be the maximum and minimum curvature as well as the maximum dip angle and azimuth

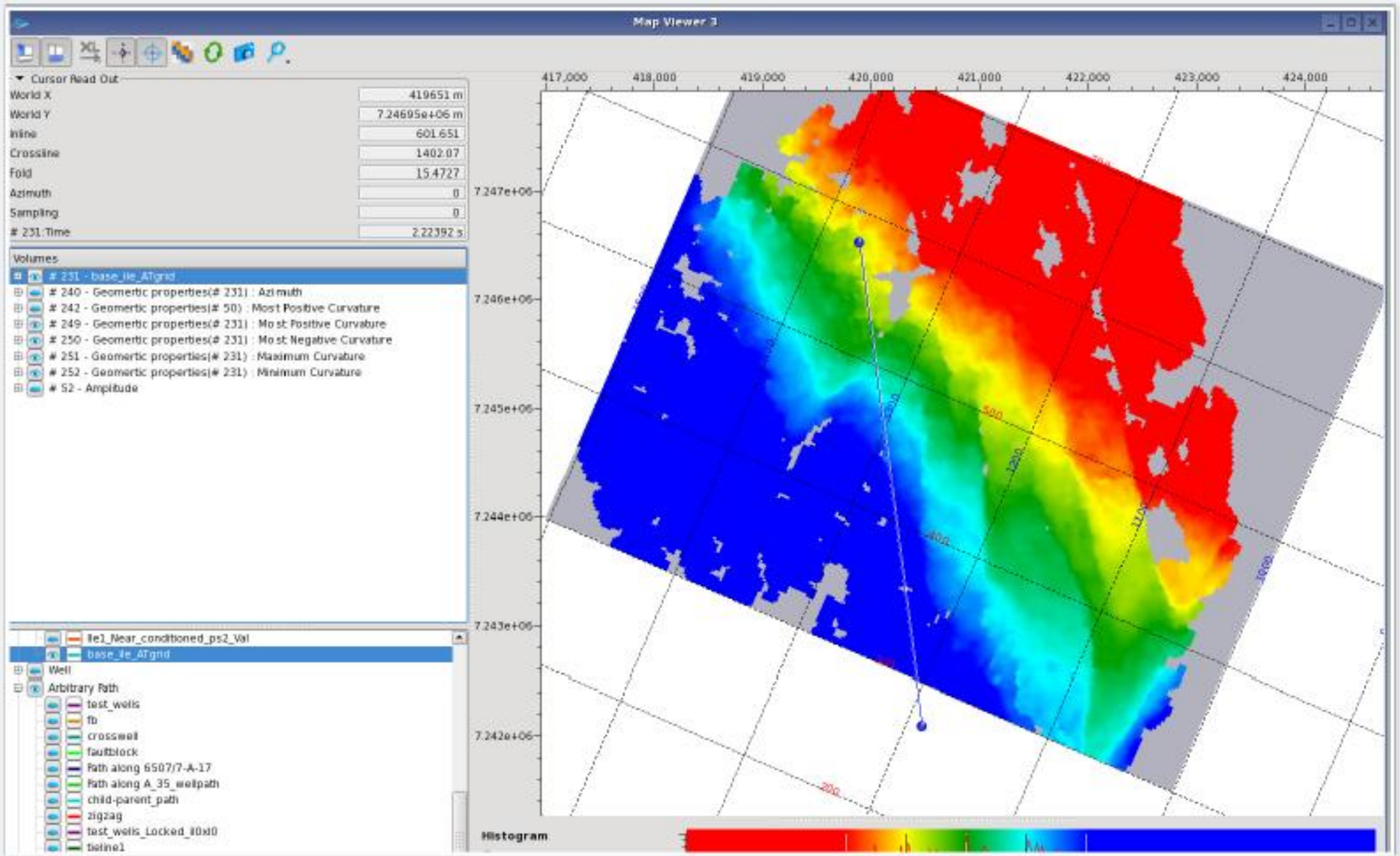
Geometric Properties



Maximum dip angle computed on a synthetic checkerboard

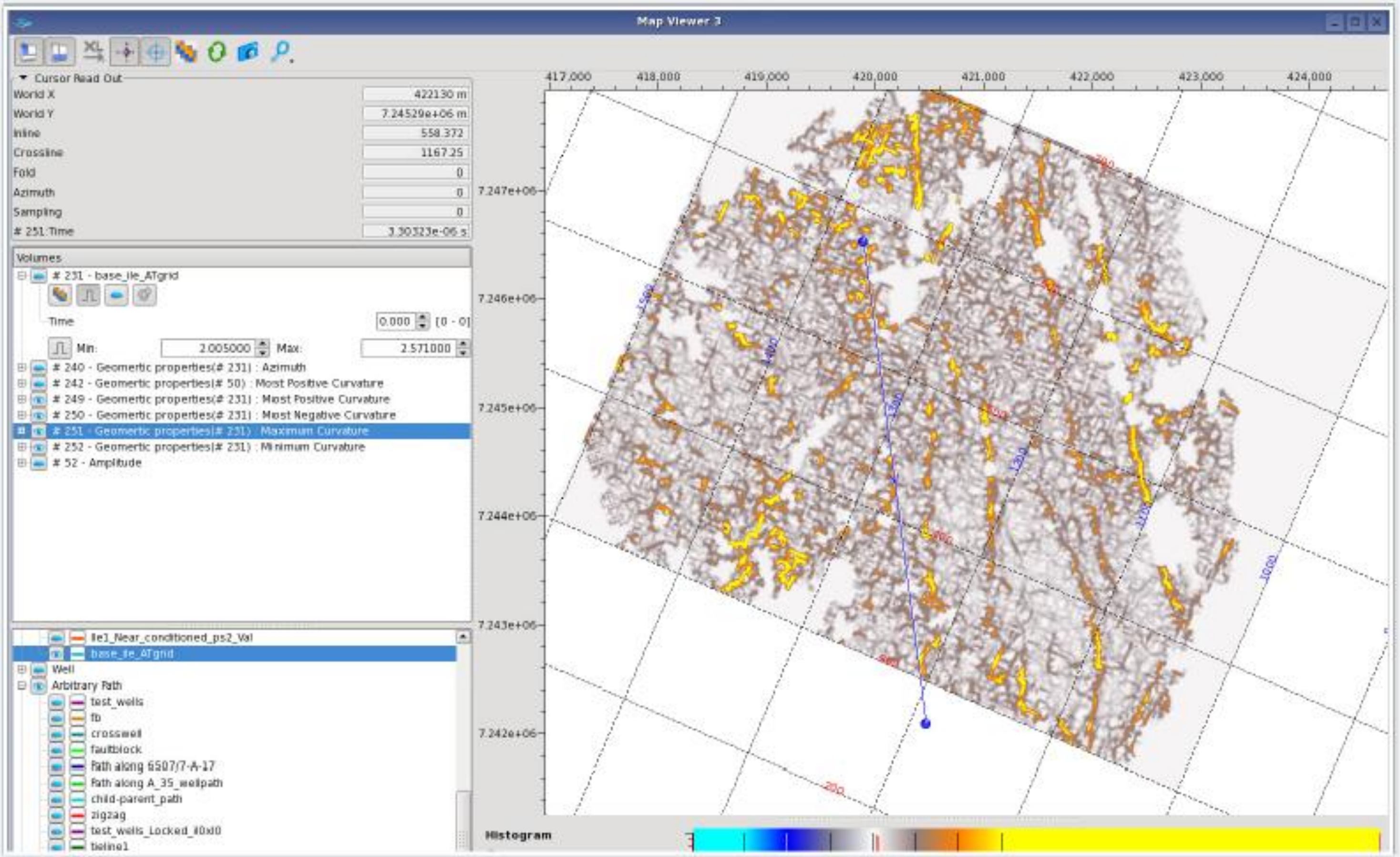
Max Curvature

Input horizon



Examples

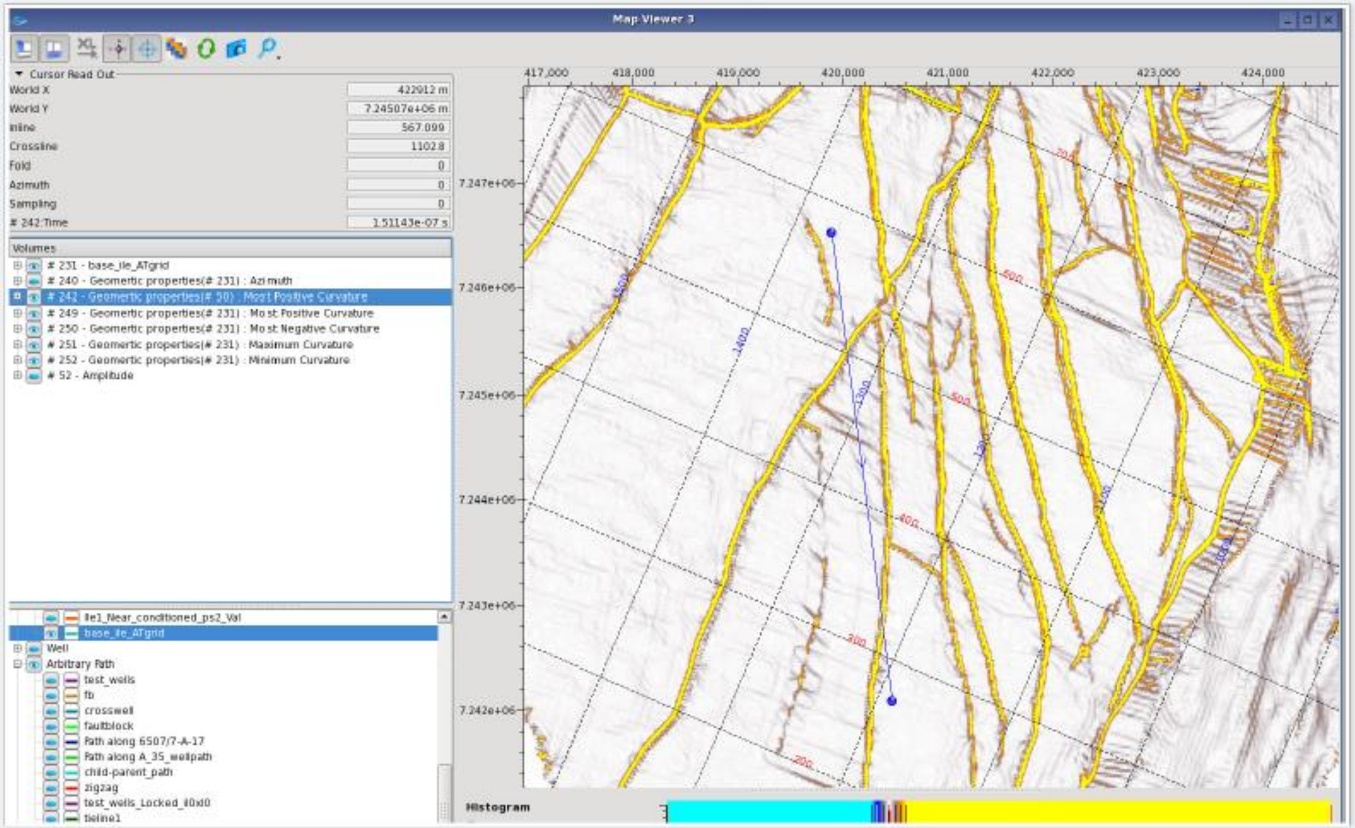
Max Curvature from Autotracked Horizon



Example

MaxCurvature from Petrel Grid

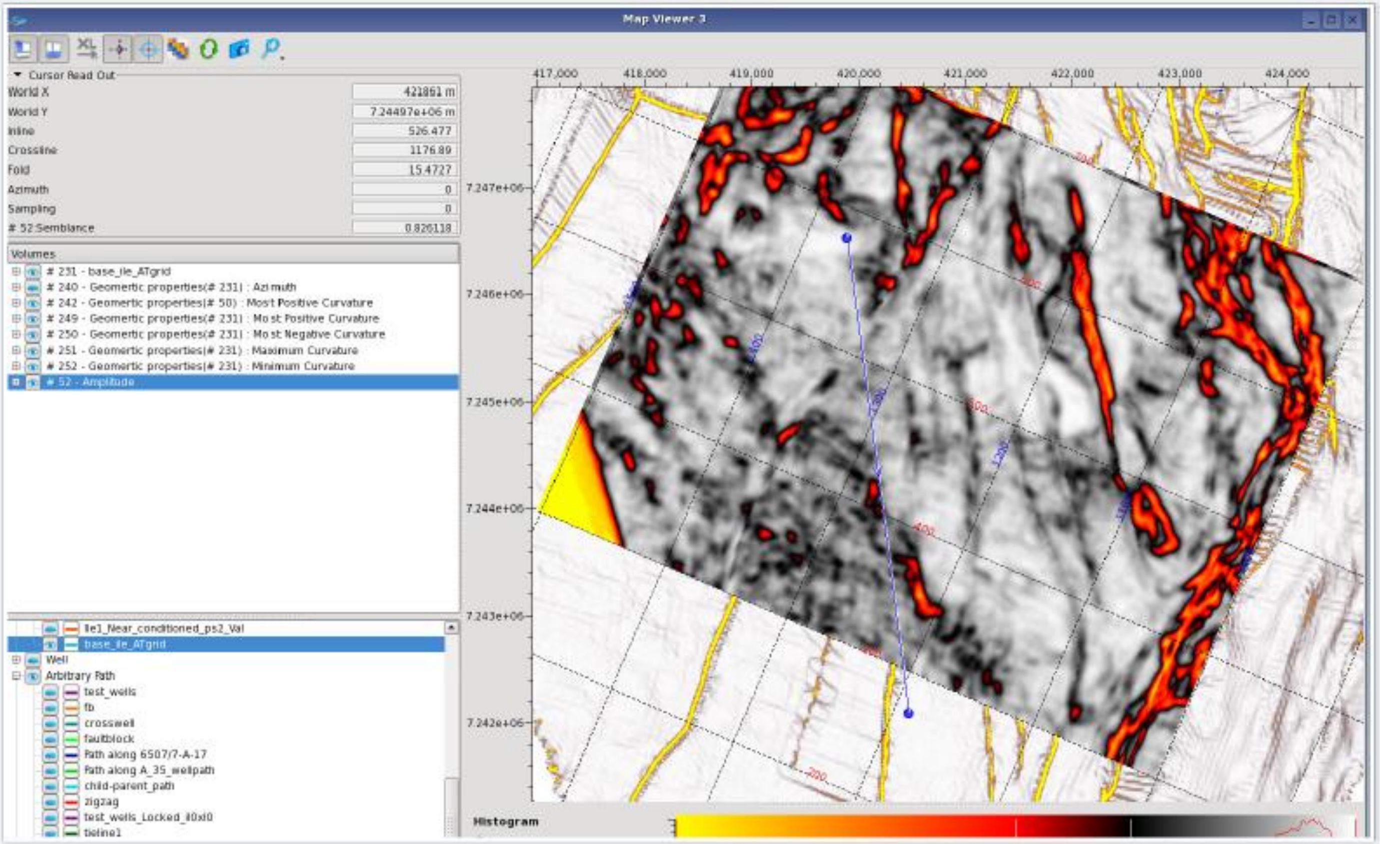
Easy to see the faults used in the framework model



Examples

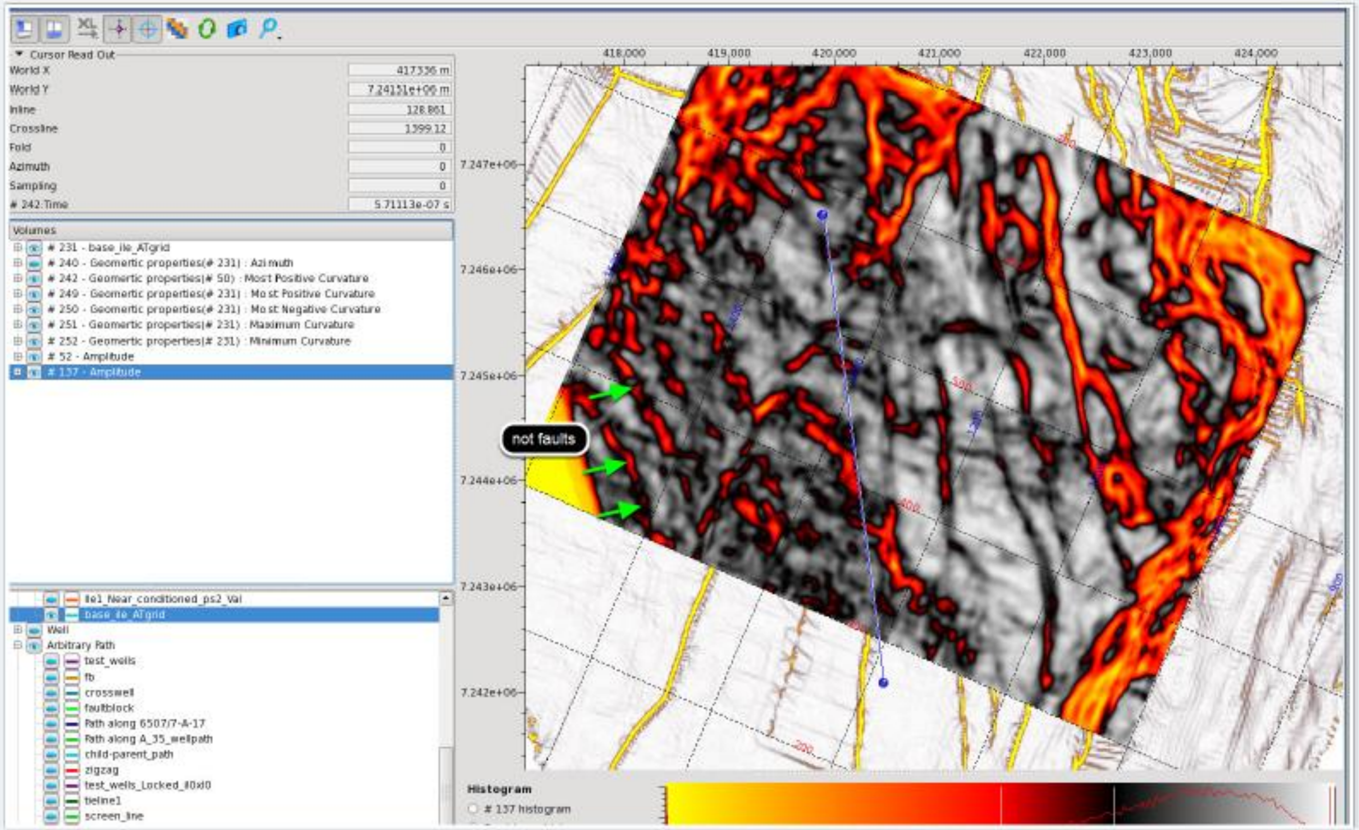
Dip-Steered Semblance Extracted from Base Ile Horizon

Used Gridded Base Reservoir to Extract DS Semblance from Create Maps



"Normal" Semblance for Same Base Reservoir Horizon

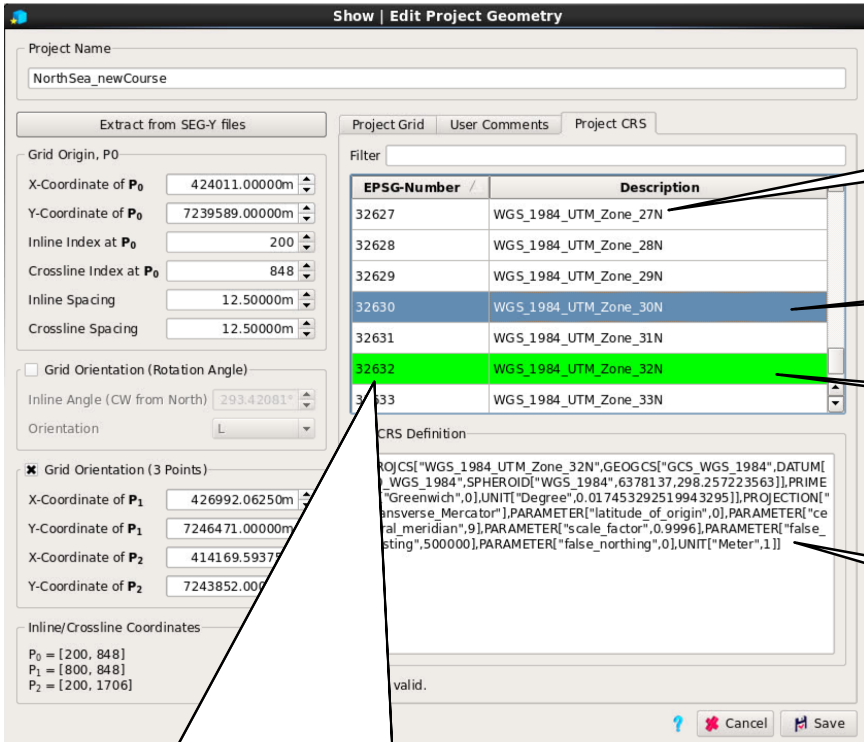
Picks up many features that are not faults - particularly in Western fault block (arrows)



COORDINATE REFERENCE SYSTEMS (CRS) AND CULTURAL DATA

Project Coordinate Reference System (CRS)

- **Project CRS is defined in Project->Edit Project Geometry in the tab Project CRS**



Name of CRS

Blue: Cursor marked CRS

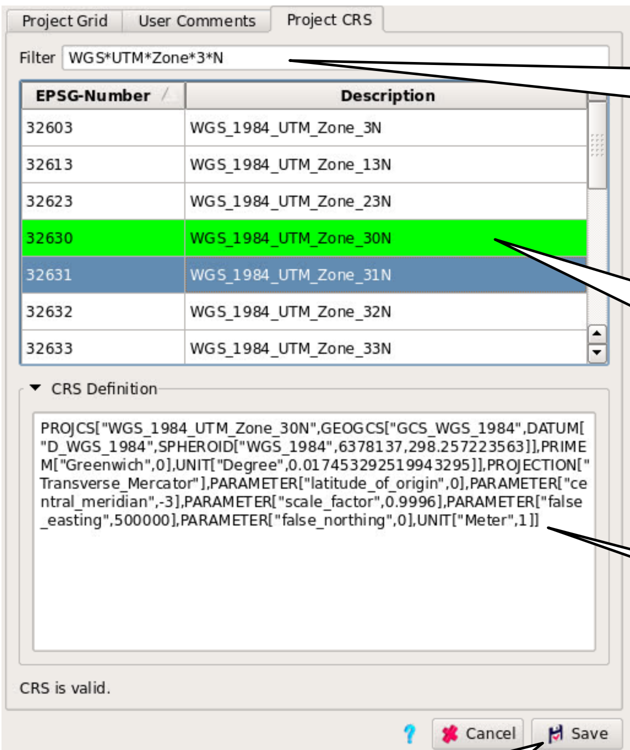
Green: Currently chosen Project CRS

Complete definition of Project CRS – in Well-Known Text (WKT) format

Number in the IOGP's EPSG Geodetic Parameter Dataset. IOGP : International Association of Oil & Gas Producers. EPSG : European Petroleum Survey Group. www.epsg.org

Choosing a new CRS

- **Open Project CRS tab in Project->Edit Project Geometry**
- **Choose a new CRS from the predefined list**
- **Double click on the new CRS (turns green), and Save**



Filter used to reduce the number of possible CRS's. Only CRS's that fit the filter will be visible. Use wildcard * between text strings.

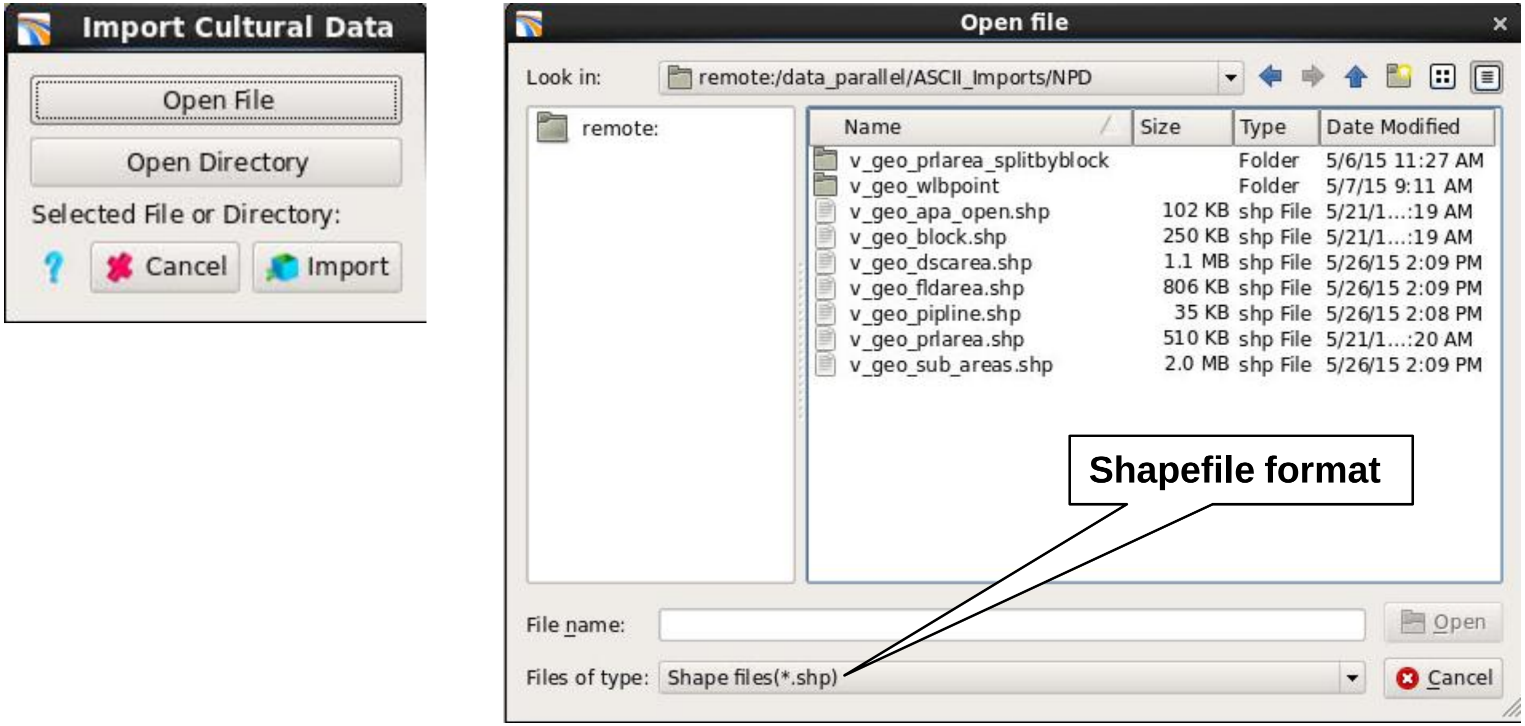
After double clicking on a given CRS, it will be chosen as the Project CRS.
Notice that whenever the user marks a CRS by clicking on it, it will turn blue. When choosing a new CRS by double clicking on it, the new CRS will look blue. If the user moves the cursor to another CRS and marks it by clicking once – this CRS will turn blue, while the chosen Project CRS will be visible as green.

The CRS Definition will be updated when choosing a new Project CRS.

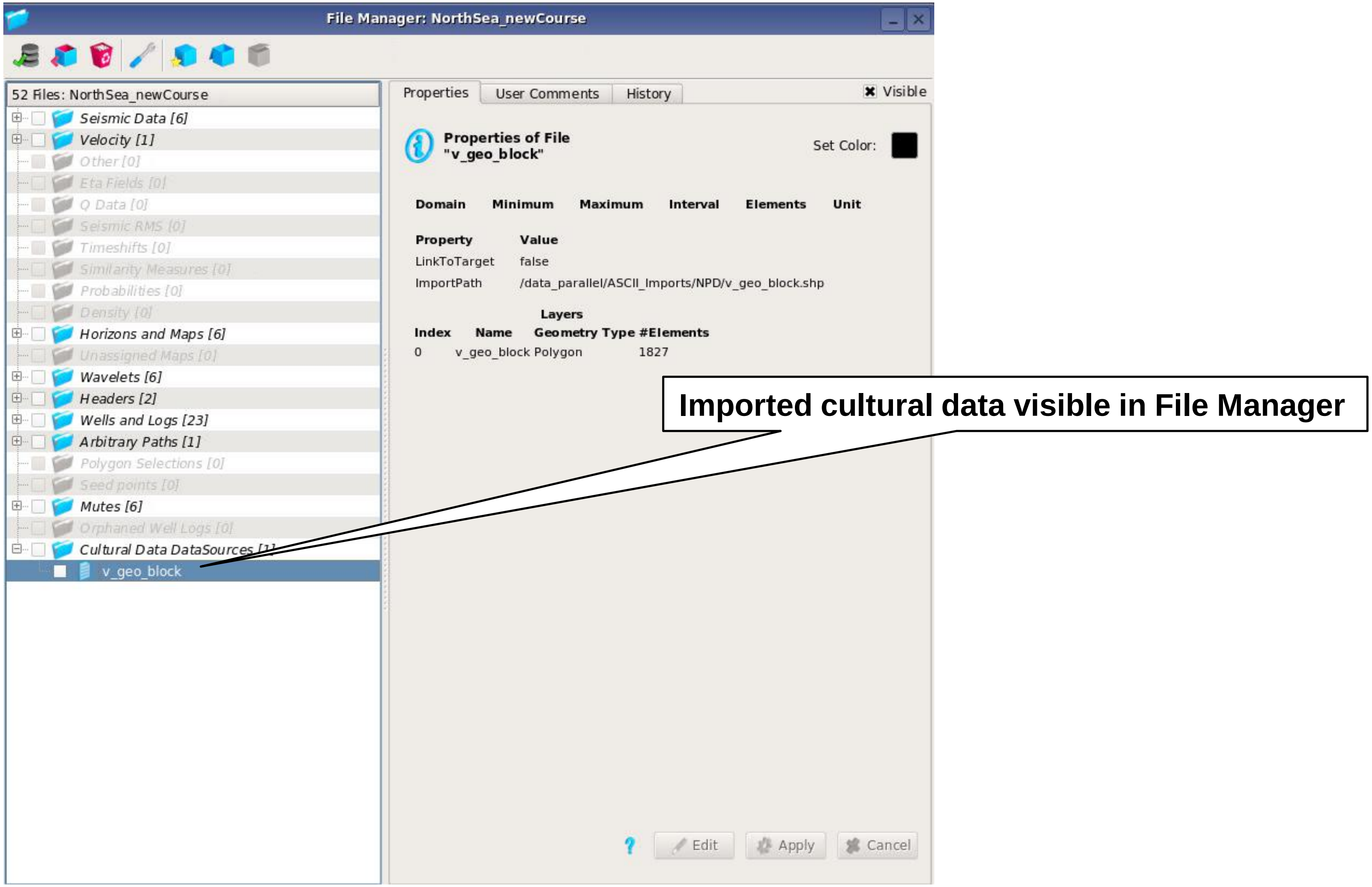
Save the new Project CRS

Cultural data - import

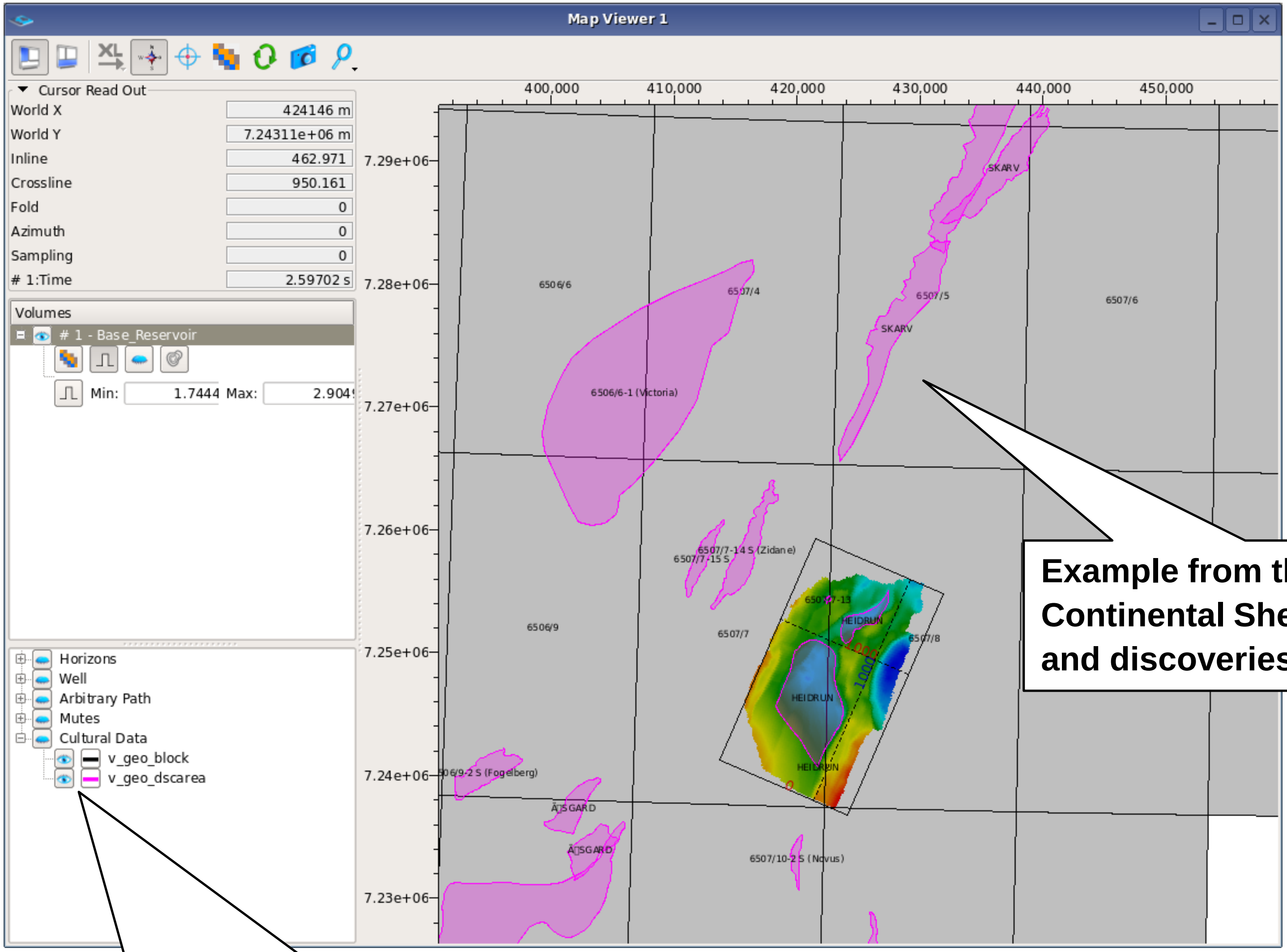
- Project → Import → Import Cultural Data...
- Input a file or directory with cultural data in shapefile format.



Cultural data – in File Manager



Cultural data – in Map Viewer



Example from the Norwegian Continental Shelf: Block data and discoveries.

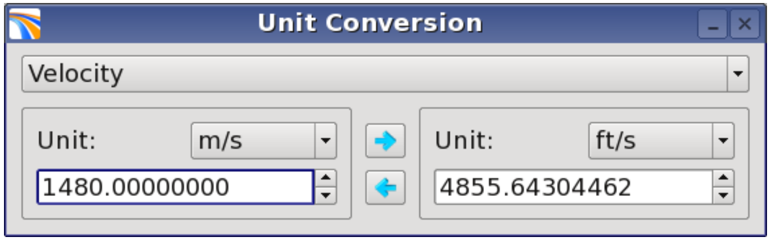
Turn visualization on/off, and change color.

Cultural data and coordinate reference system

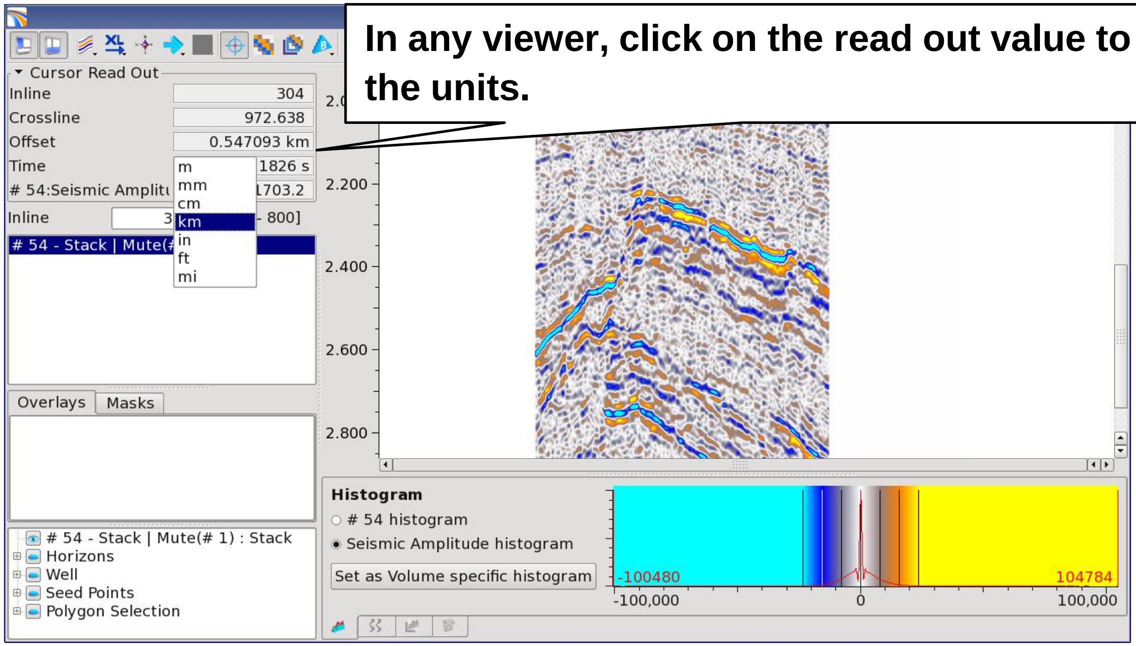
- The shapefile contains information about the UTM zone for the imported cultural data.
- PSPRO will convert or transform the imported cultural data to the project defined coordinate reference system.
- There is no coordinate conversion or transformation for project data (seismic, horizons, well locations etc.).
- It is still the user’s responsibility to import project data in a consistent way, i e. that the coordinates for all project data are imported with the same UTM zone.

UTILITIES

Unit conversion



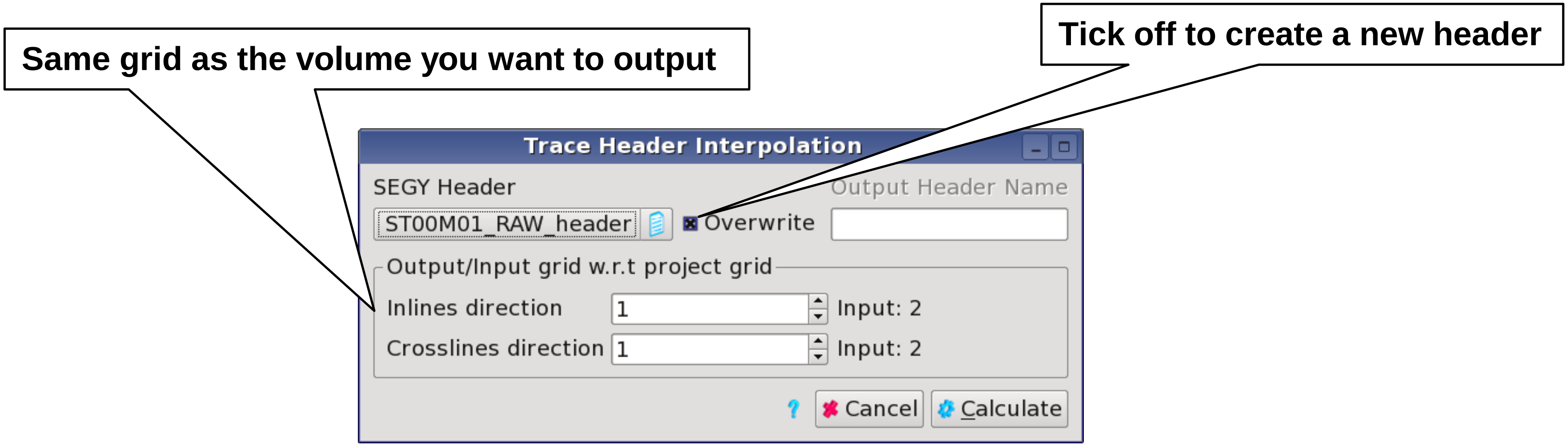
- **Utilities → Unit converter**



In any viewer, click on the read out value to change the units.

Trace header interpolation

- Utilities → Trace header interpolation
- Workflow for interpolating a stack and using the header for SEG-Y output
  - Interpolate the stack volume
  - Interpolate the original headers to the same geometry
  - In SEG-Y output, used the interpolated header to copy the X/Y locations



SUPPORT OF MULTI AZIMUTH DATA

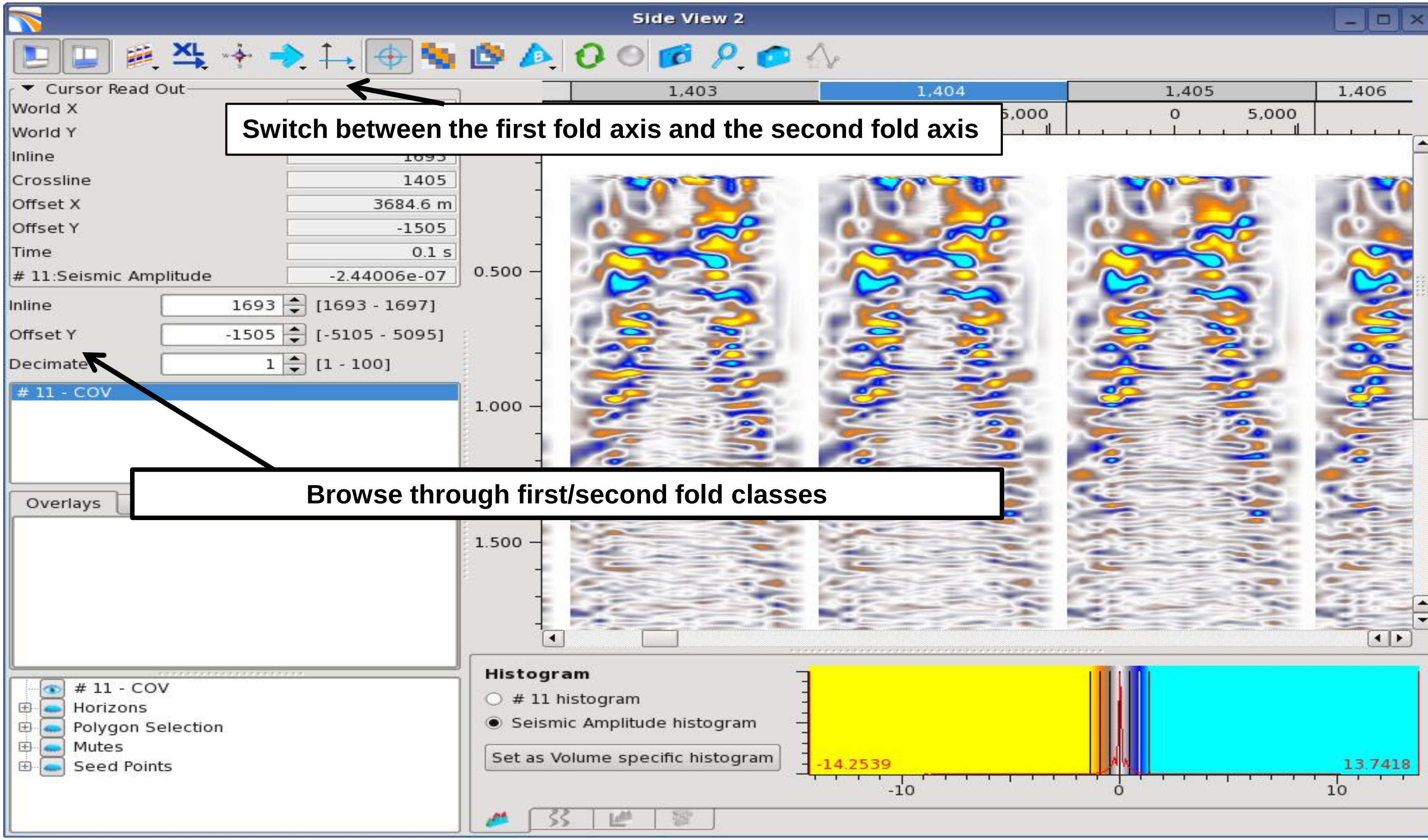
Import of Irregular files

- Pre-Stack Pro currently do not handle the import of 5D irregular SEGY files.

- For this you will need the tool *Seismic Data Certification* developed by *Fraunhofer ITWM.*

- Please contact directly *Dr. Norman Ettrich* to request the binary and user manual: *norman.ettrich@itwm.fraunhofer.com*

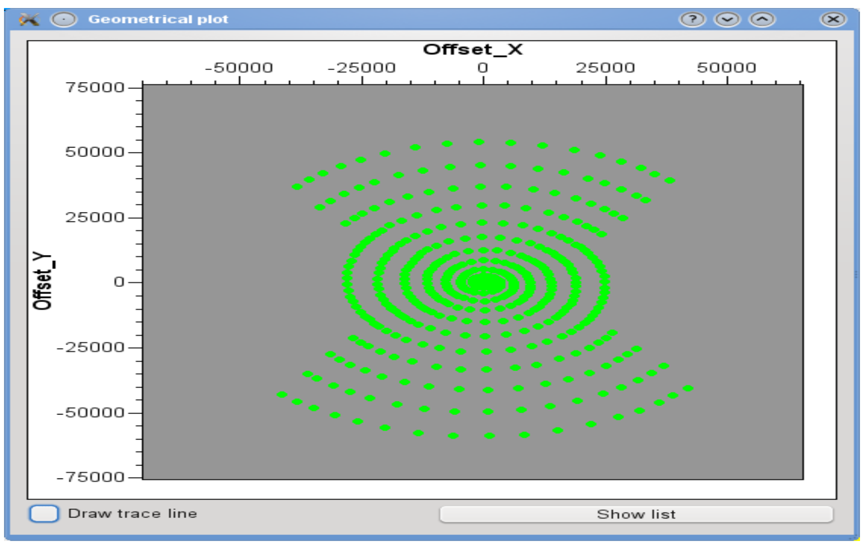
2D Viewers

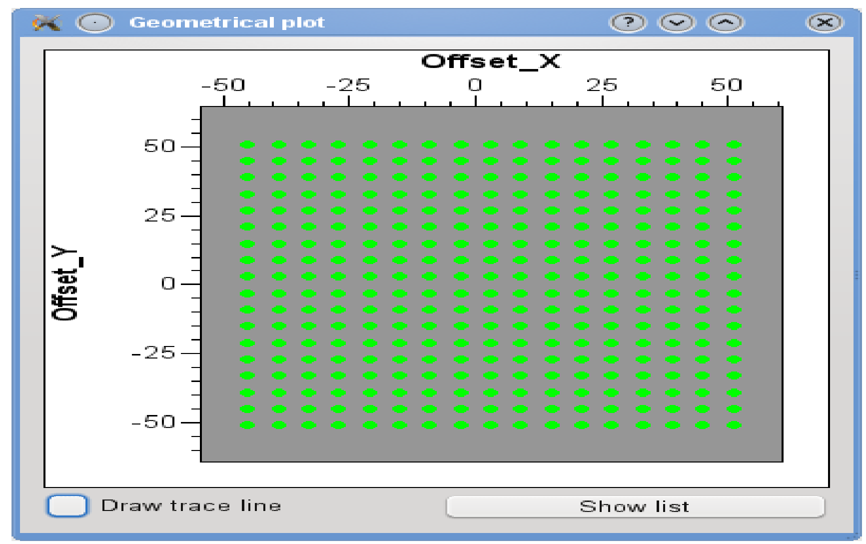


COV gathers displayed in the prestack viewer

2D Viewers

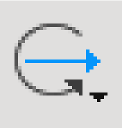
- **Supported input data are:**
  - **COV (common offset vectors)**
  - **COCA (common offset common azimuth)**
  - **CICA (common incidence angle common azimuth)**



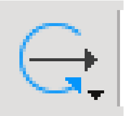


COCA/CICA gather = polar binning	-	COV gather= Cartesian binning

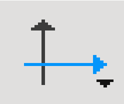
2D Viewers



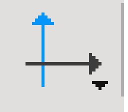
Look at your COCA/CICA gather along the offset/angle direction for constant azimuth sectors



Look at your COCA/CICA gather along azimuth direction for constant offset/angle slices



Look at your COV gather along the Offset X direction



Look at your COV gather along the Offset Y direction

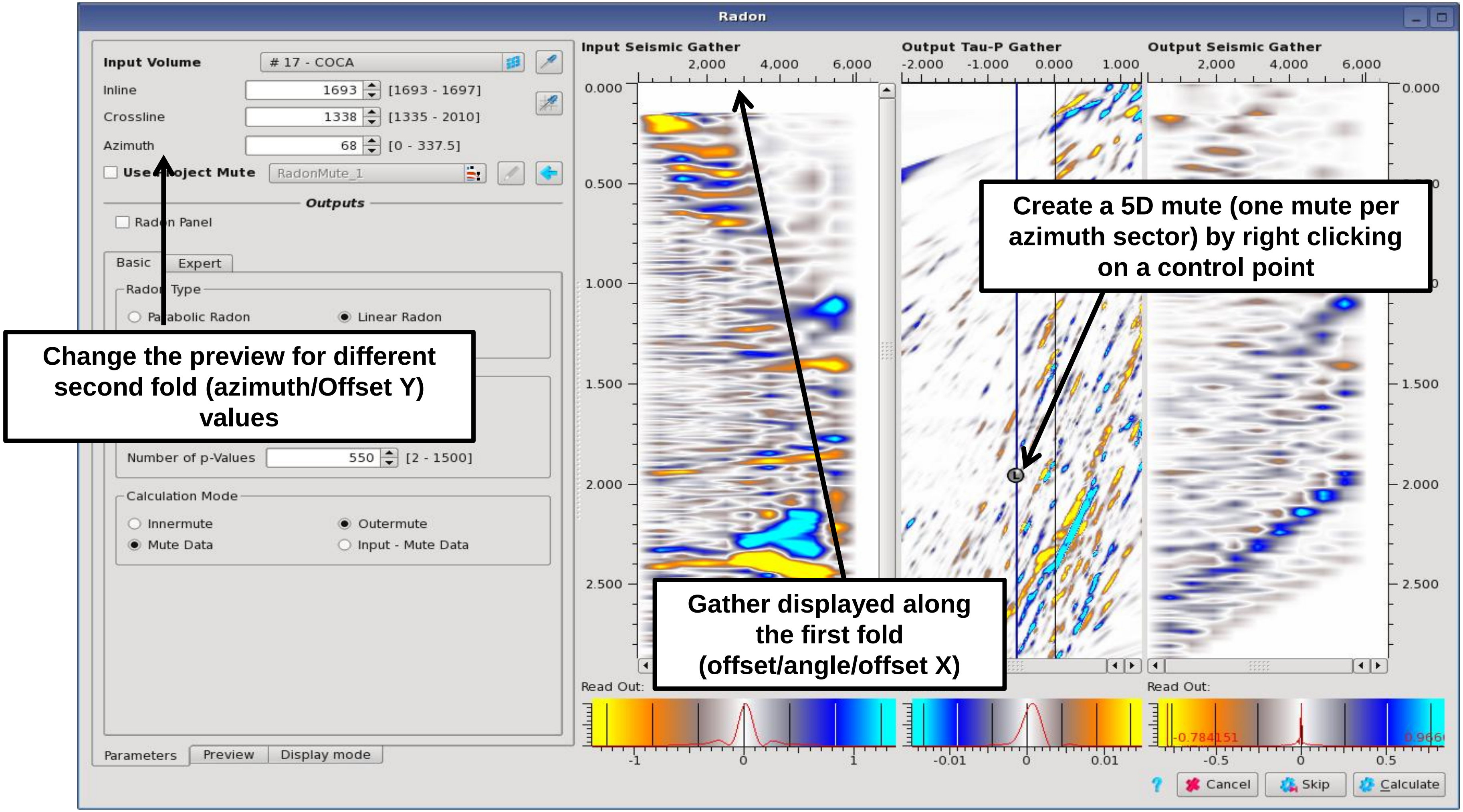
Algorithms

- Most algorithms have been extended to handle 5D data.
- However, the following ones can't currently have multi-azimuth gathers as input:
  - EPS 3D
  - Q Models & Filters
  - Tau-p decon
  - Semblance Optimization
  - Continuous Velocity Analysis
  - Dip Filter
  - PCube
  - Structural Dip
  - Multi Well Scalar
  - AVO Scaling
  - RMO
  - Offset Interpolation

Algorithms

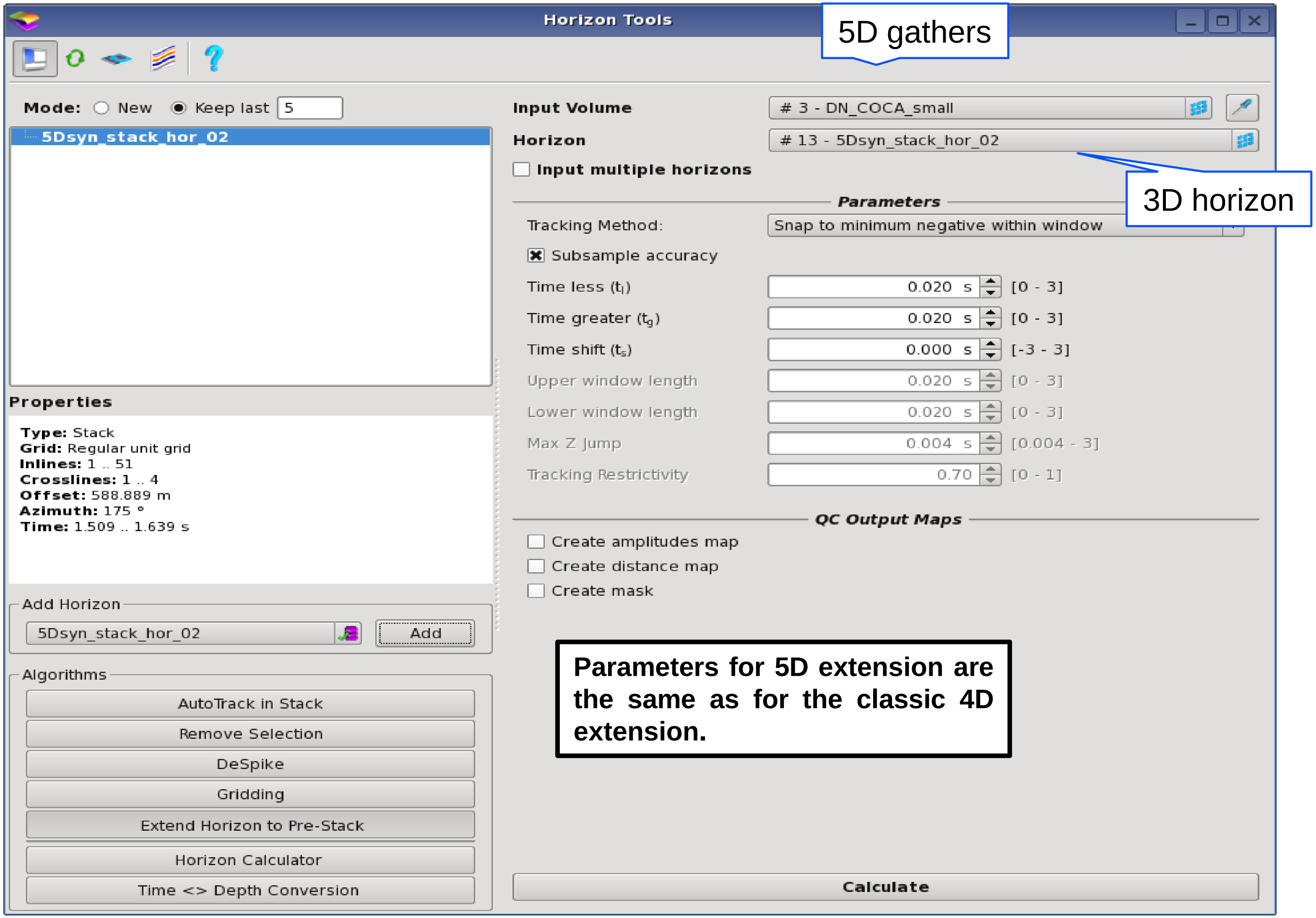
- In addition, some algorithms will only allow COCA or CICA gathers (mostly for Geophysical reasons):
  - Offset to Angle (and reciprocal)
  - Radon
  - 2D ECED
  - AVA attributes

Algorithms



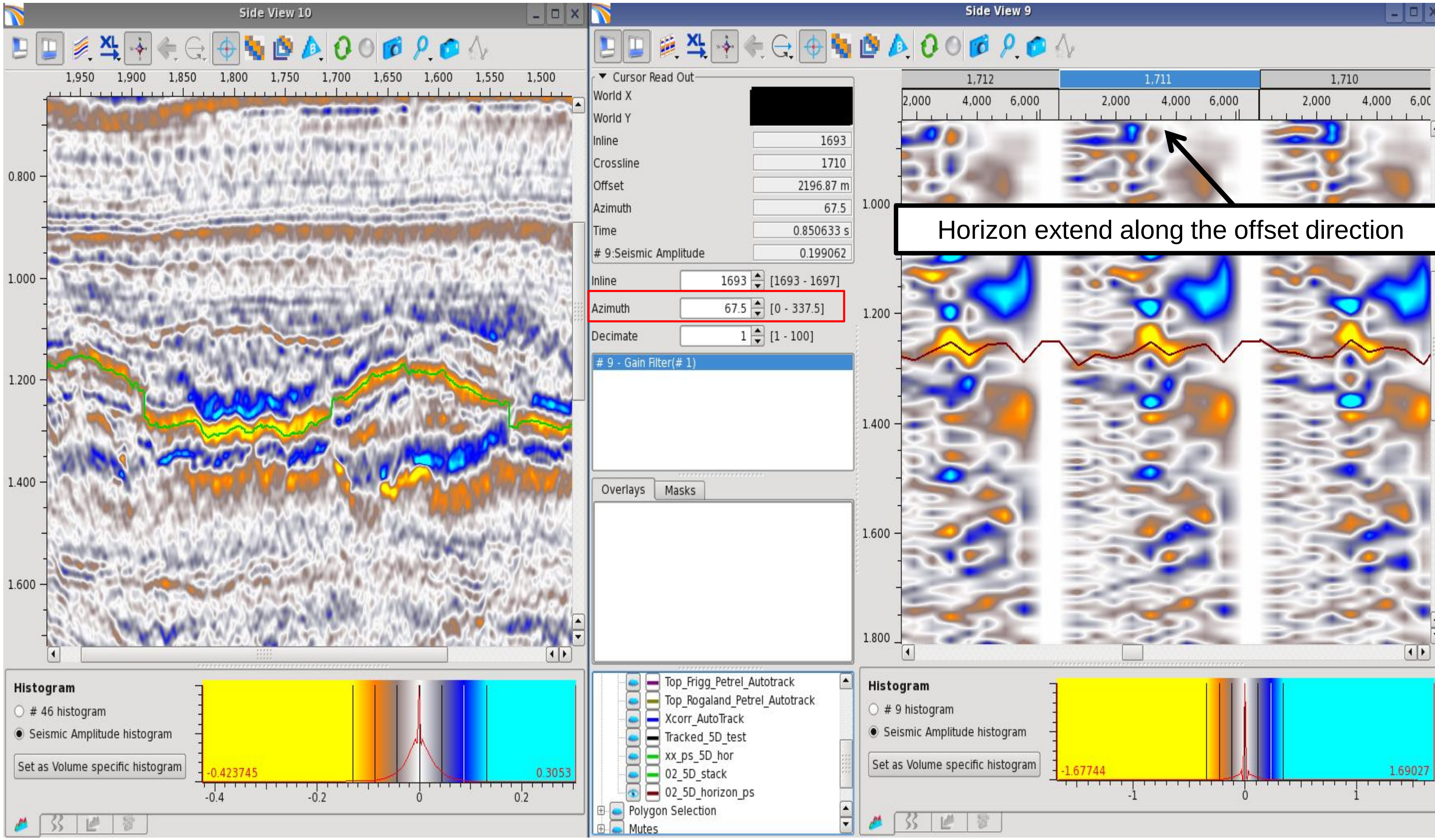
Linear Radon muting on COCA gathers

5D Horizon Tracking



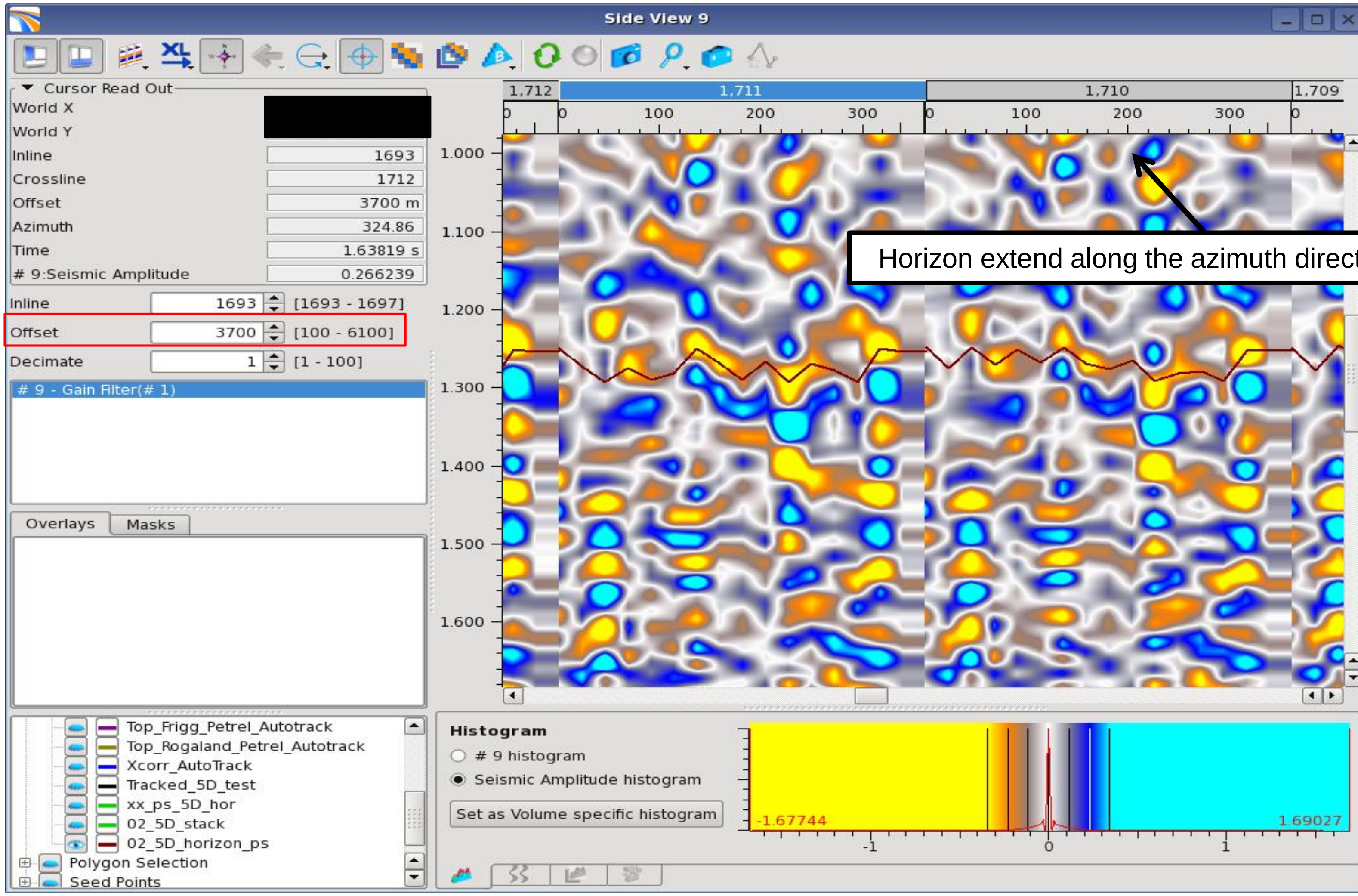
Parameters for 5D extension are the same as for the classic 4D extension.

5D Horizon Tracking



Extend your horizons to prestack both in the offset and azimuth direction

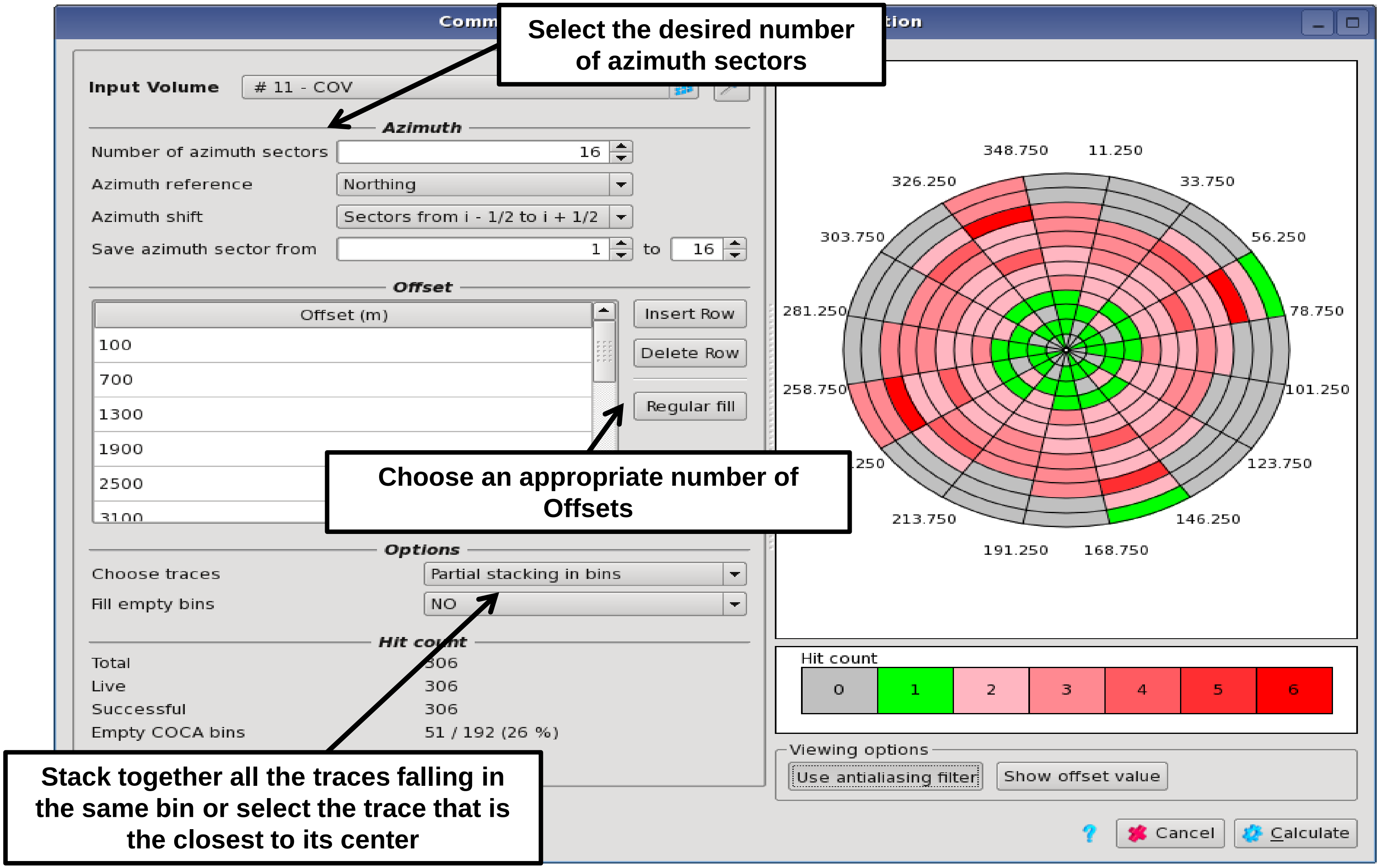
5D Horizon Tracking



Extend your horizons to prestack both in the offset and azimuth direction

COCA Sectorization

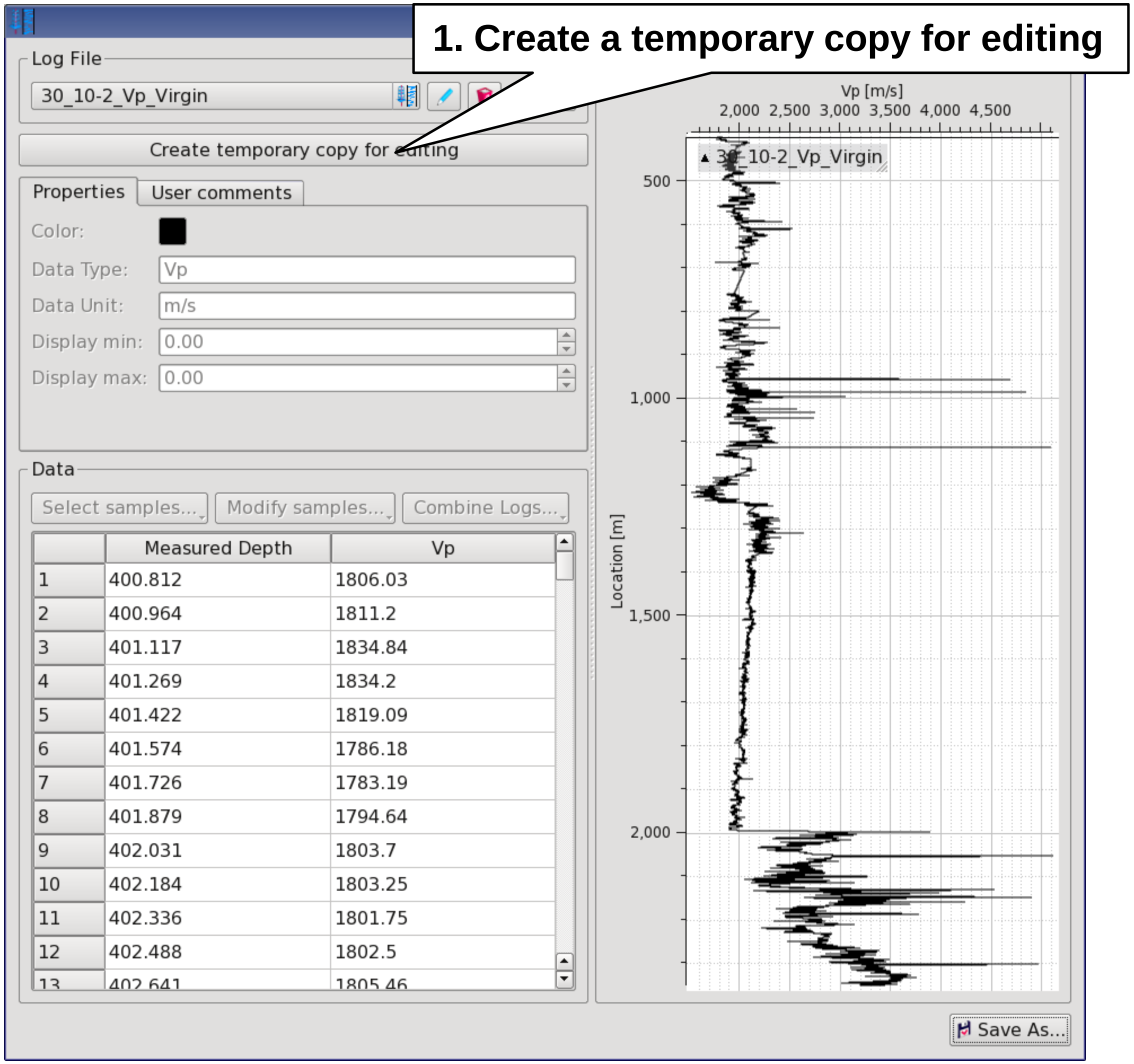
sharpreflections



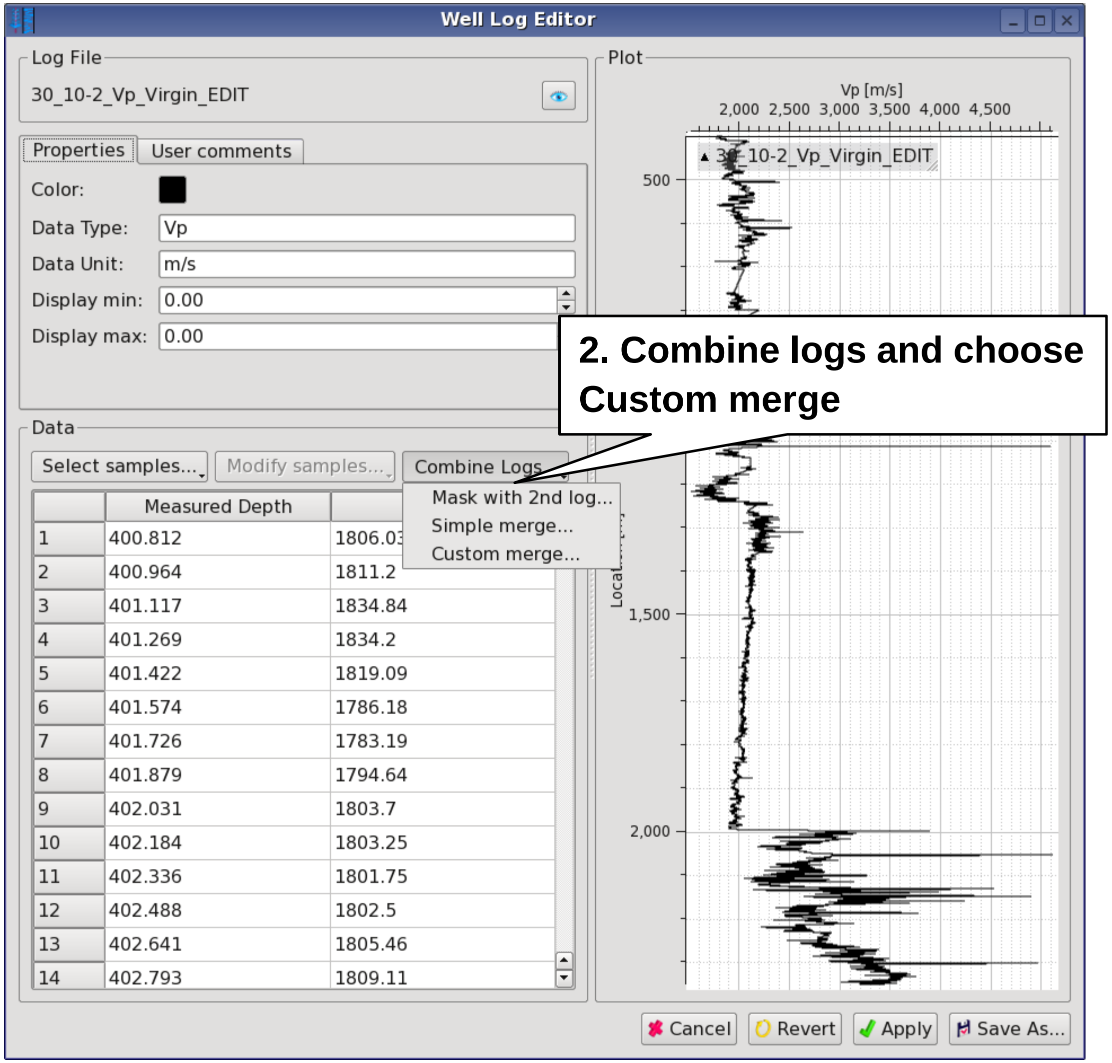
Rebin your data from COV (Cartesian) to COCA (polar)

WELL LOG VIEWER

Well Log Editor → Custom edits

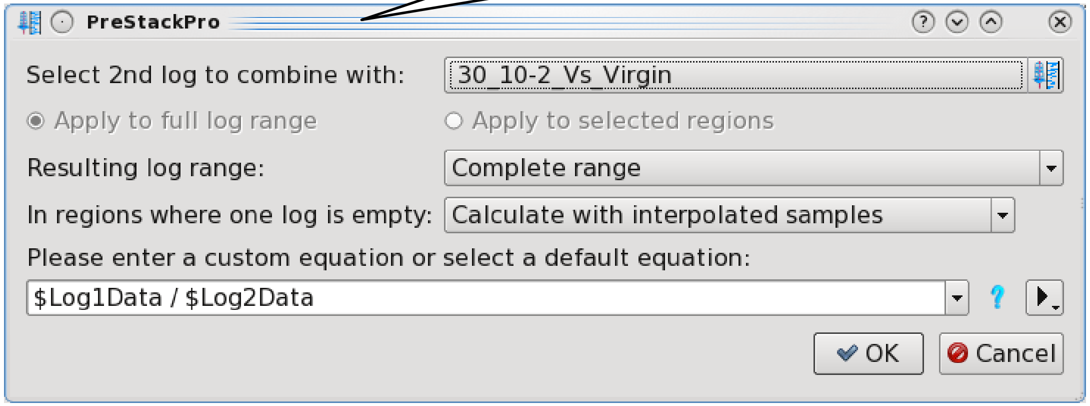


Well Log Editor → Custom edits

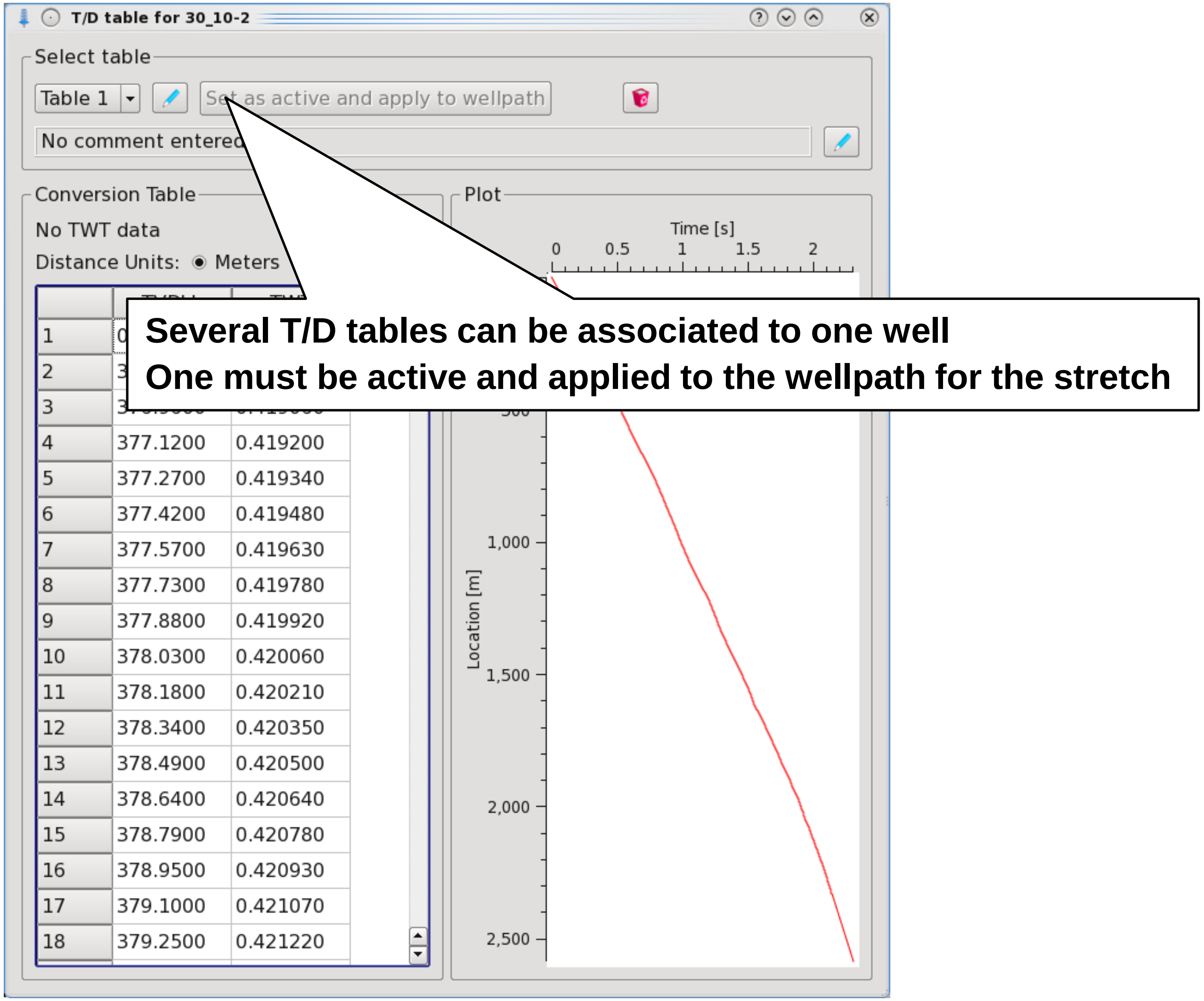


Well Log Editor → Custom edits

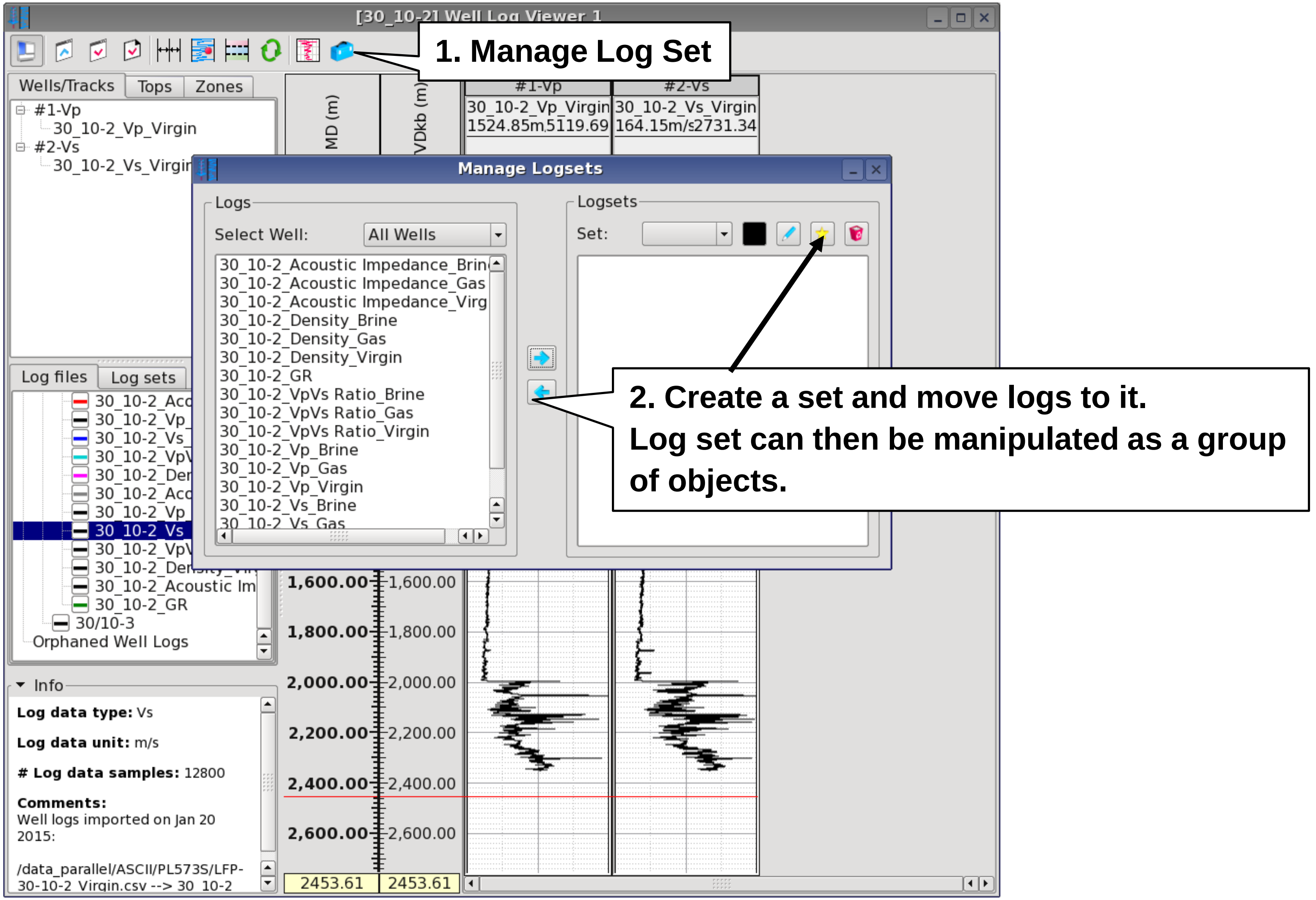
3. Choose 2nd log and use Custom Equation to create a new log.
In this example we are creating a Vp/Vs ratio



Manage Wells → T/D Tables



Well Log Set

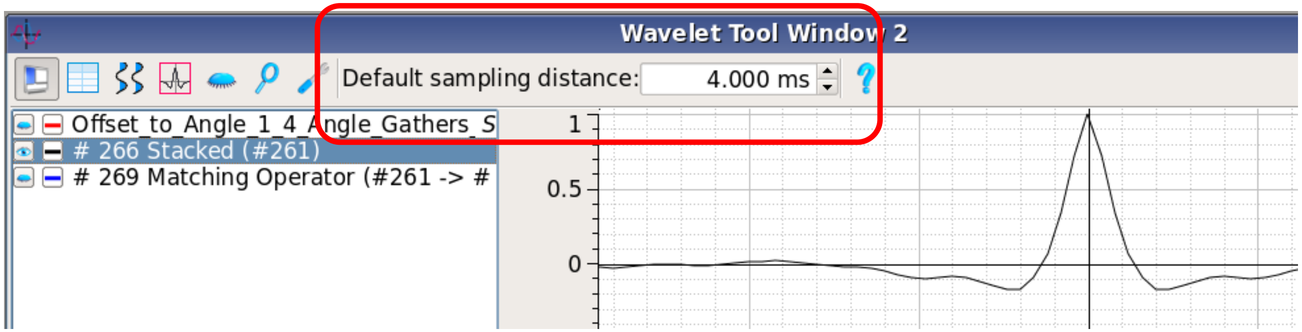

1. Manage Log Set
2. Create a set and move logs to it.
Log set can then be manipulated as a group of objects.

WAVELET TOOL

New Features

- Setting the default sample interval
- Reorganised menus
- Automatic zero-phasing on load
- Creating spectra from well logs
- Coloured inversion workflow

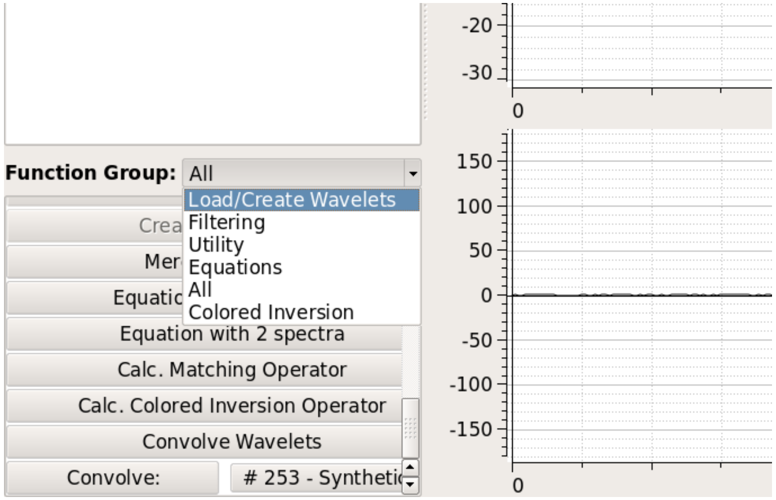
Set the default sample interval



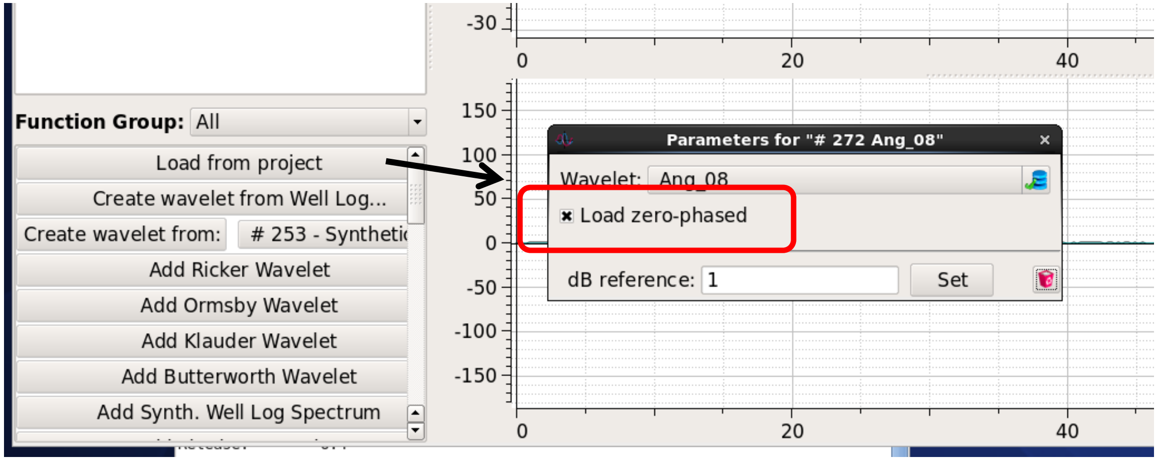
- This value is used as the default sample interval for any new wavelets created in the wavelet tool.
- Wavelets loaded from the project keep their original sample interval.
- If it is changed during a session, any wavelets already in the tool are not resampled, they keep their original sample interval. Any wavelets created after the change will have the new default sample interval.
- This is just the default value for the sample interval. The individual GUIs for adding wavelets still allow you to change the sample interval for individual wavelets.

Reorganised function menus

- The tabs have been replaced by a drop-down menu list.
- There is an item for coloured inversion to clarify the workflow.

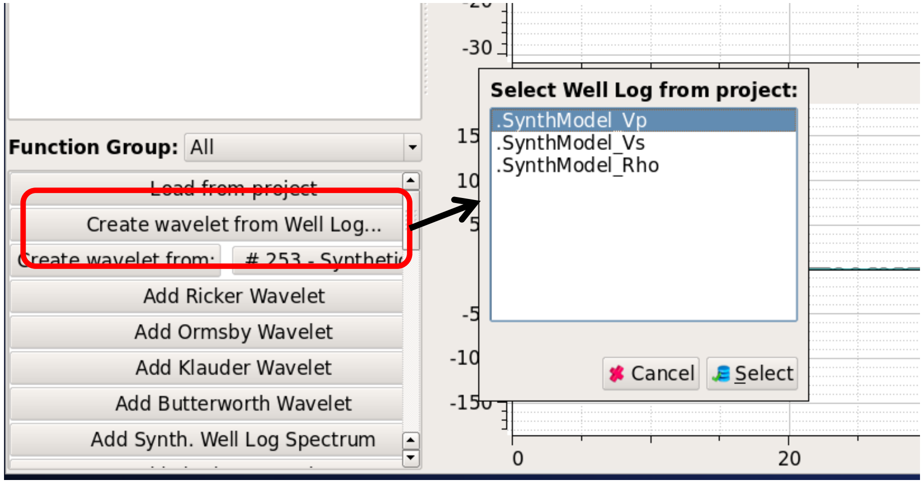


Zero-phasing on load from project

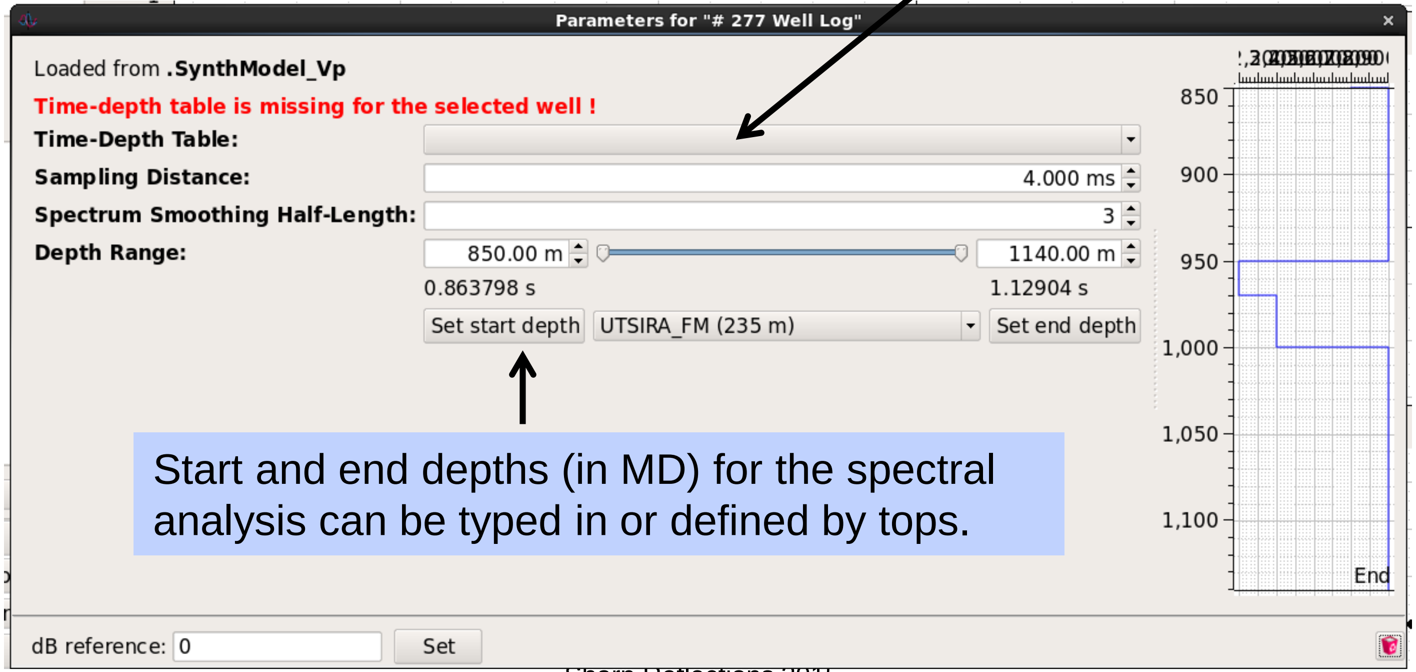


- Since the first step in many workflows is to zero-phase the extracted spectra, an option has been added to “Load from project” to perform this automatically.
- It is On by default, so don’t forget to switch it off if you need the phase information too.

Creating spectra from well logs



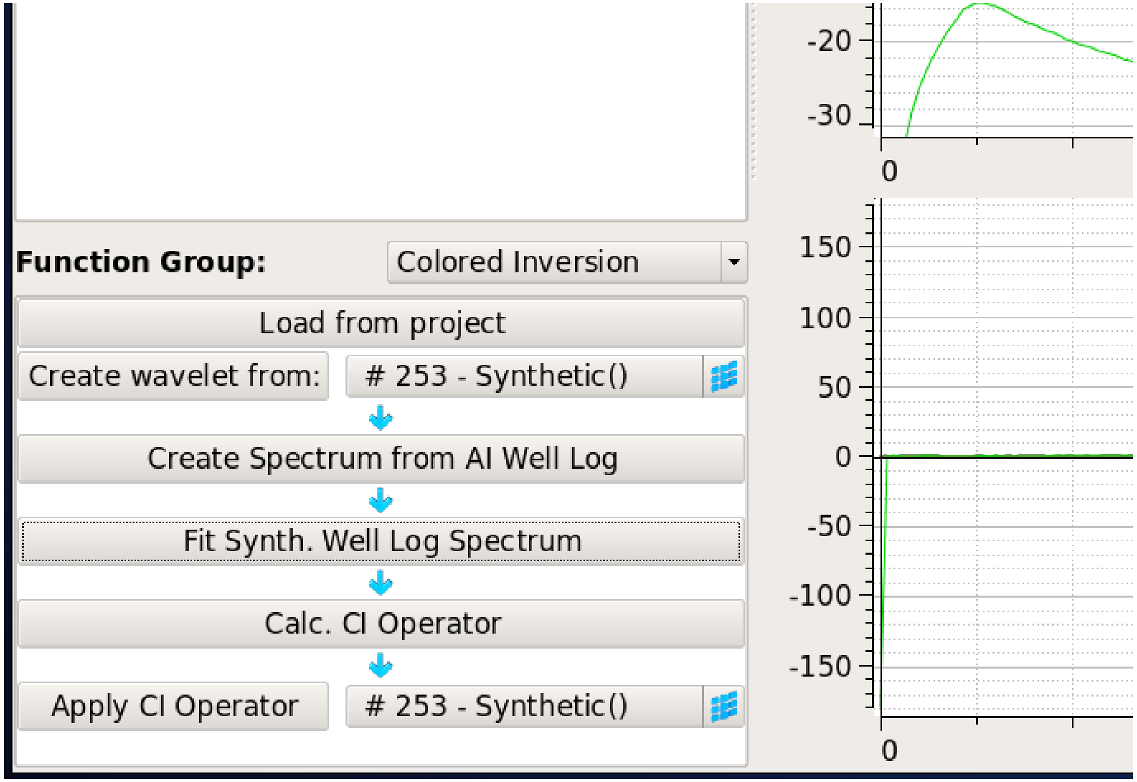
Choose a t-d table from drop-down list



Start and end depths (in MD) for the spectral analysis can be typed in or defined by tops.

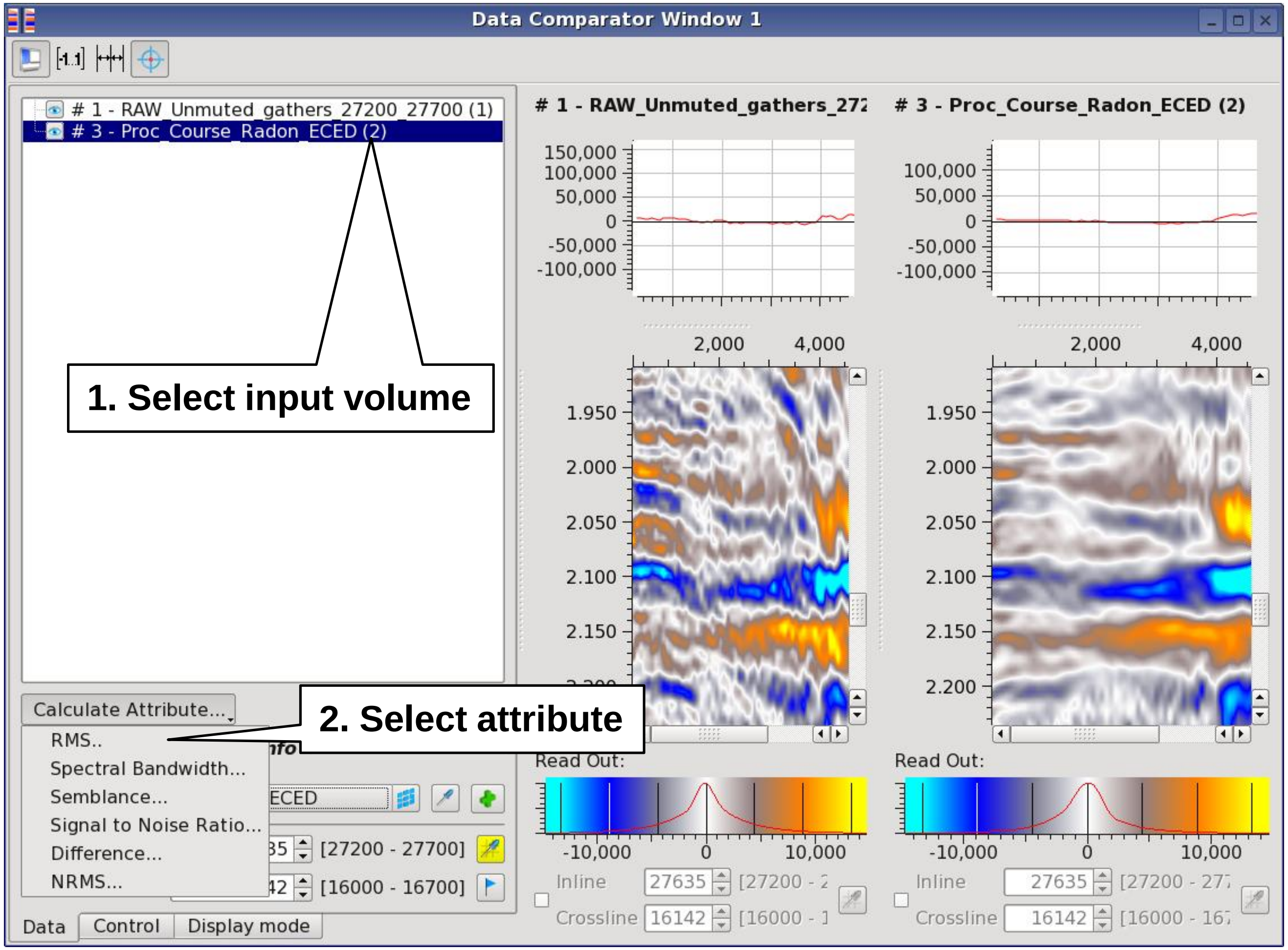
Coloured inversion

- The key steps in the coloured inversion workflow are collected in the CI Function group to clarify the workflow.
- The tools have been modified to include spectral smoothing, tapering, and filtering where necessary instead of having to use separate functions.

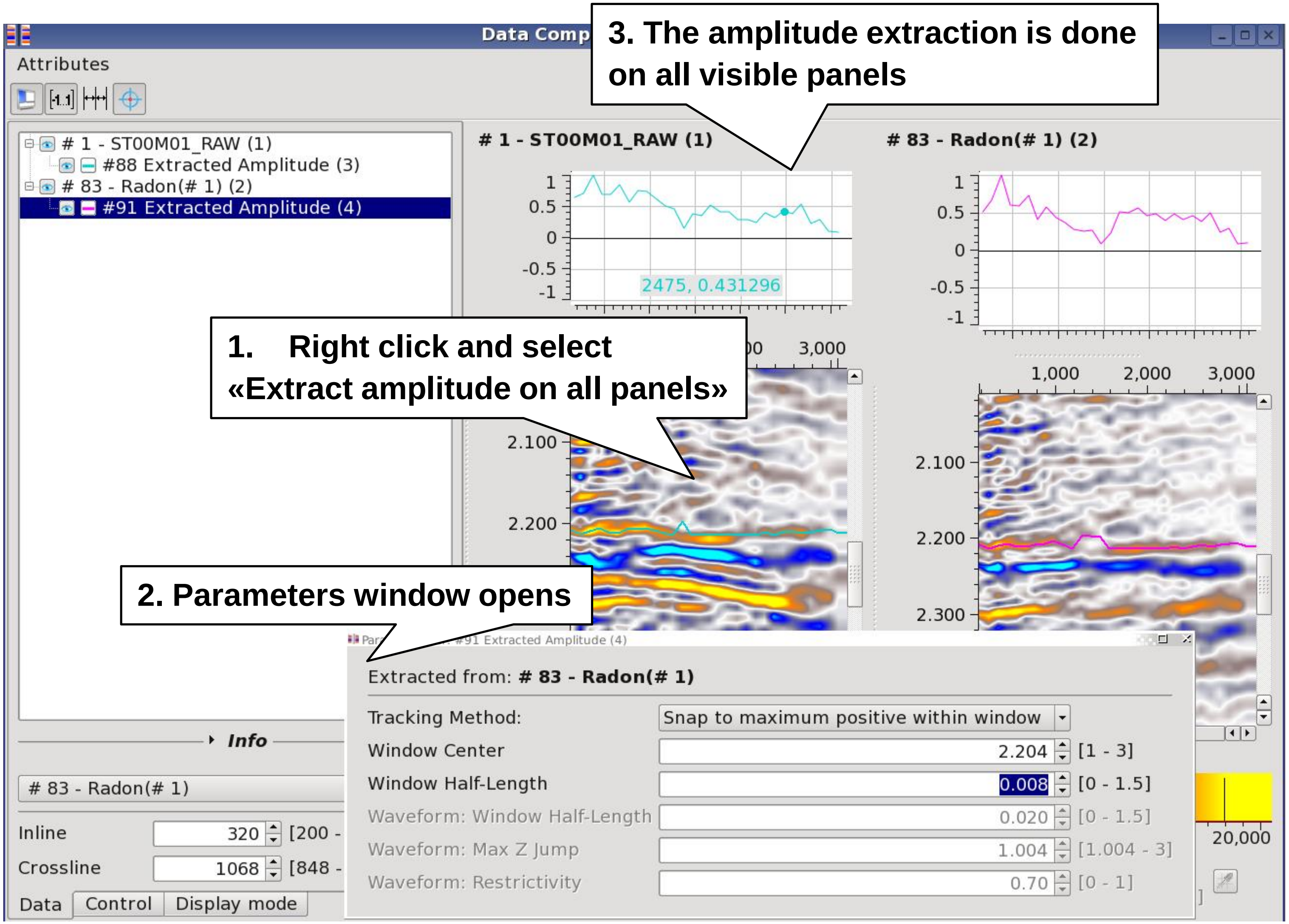


DATA COMPARATOR NEW FEATURES

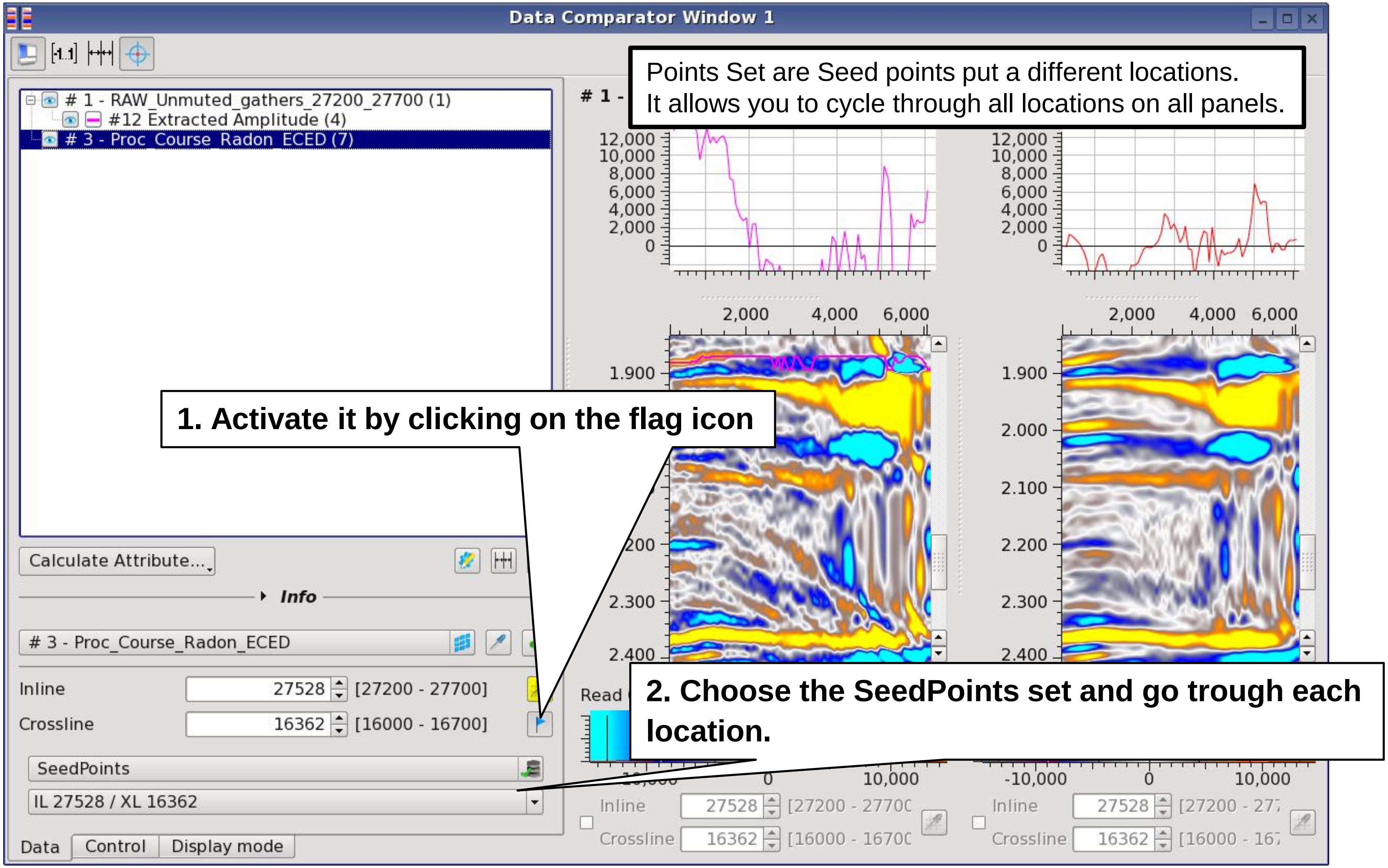
Attributes computation



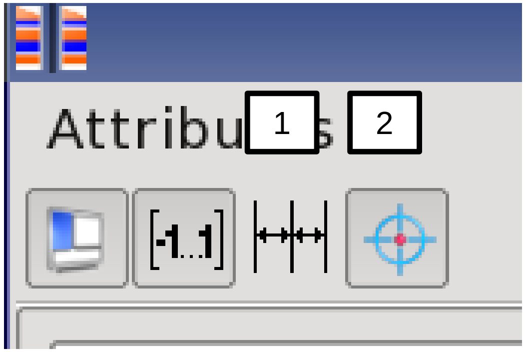
Amplitude extraction



Use of points set



New icons and other features

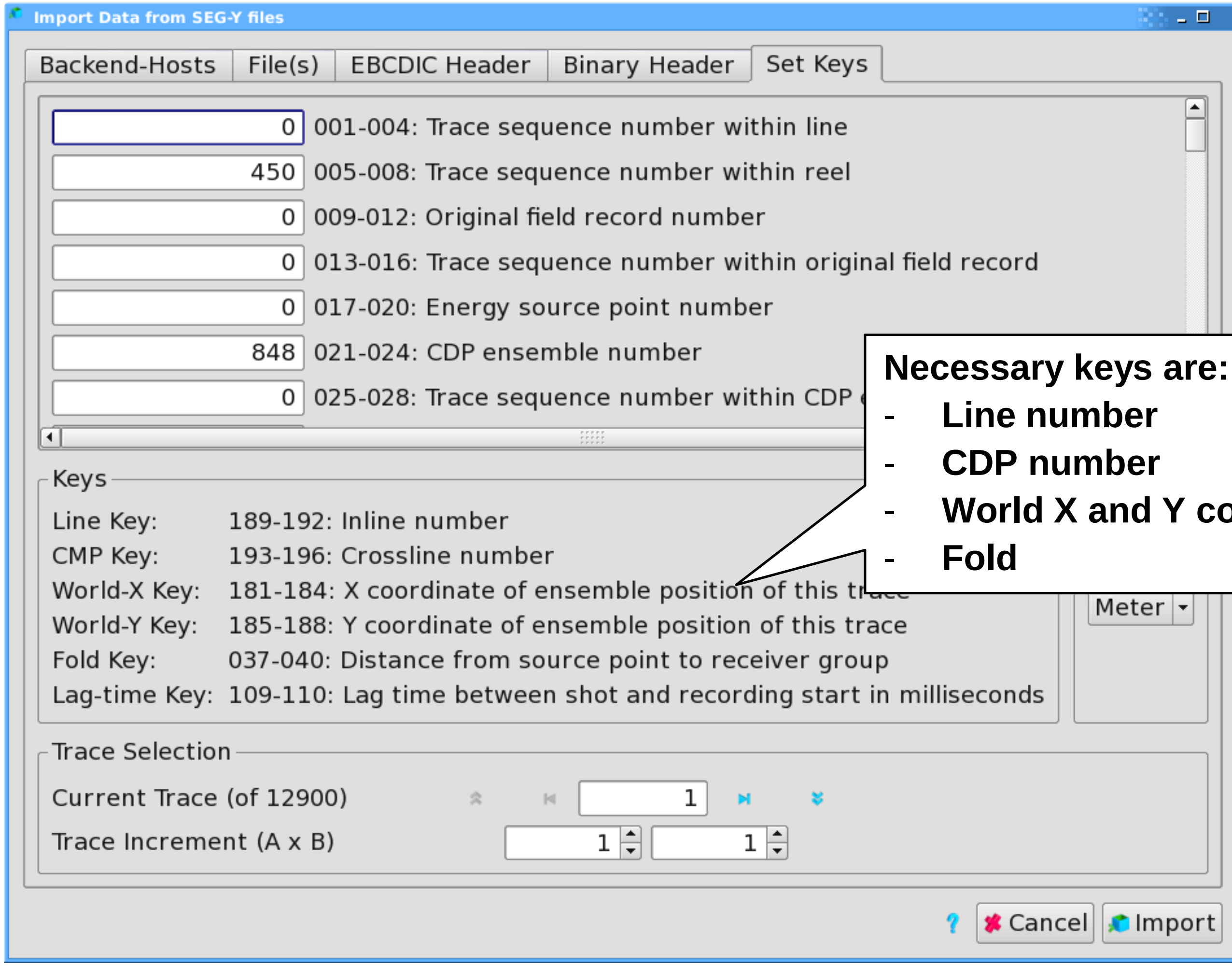


- **1. Set the width of all panels**
- **2. Toggle on/off the read out extraction for all panels**

- **A horizon that has been snapped on one panel can be used for Amplitude Extraction on another panel, when dragging the horizon on the panel there is now a small pop-up that asks whether the horizon should just be displayed on the panel or used for an extraction.**
- **The Datapanels can now be reordered using Drag & Drop in the tree and resized manually via the context menu or all at once via a toolbar button.**
- **The y− axes of the amplitude plots are now synchronized by default if the Data panel display data from the same domain. This can be disabled in the Control Tab.**

2D SEG-Y LINES

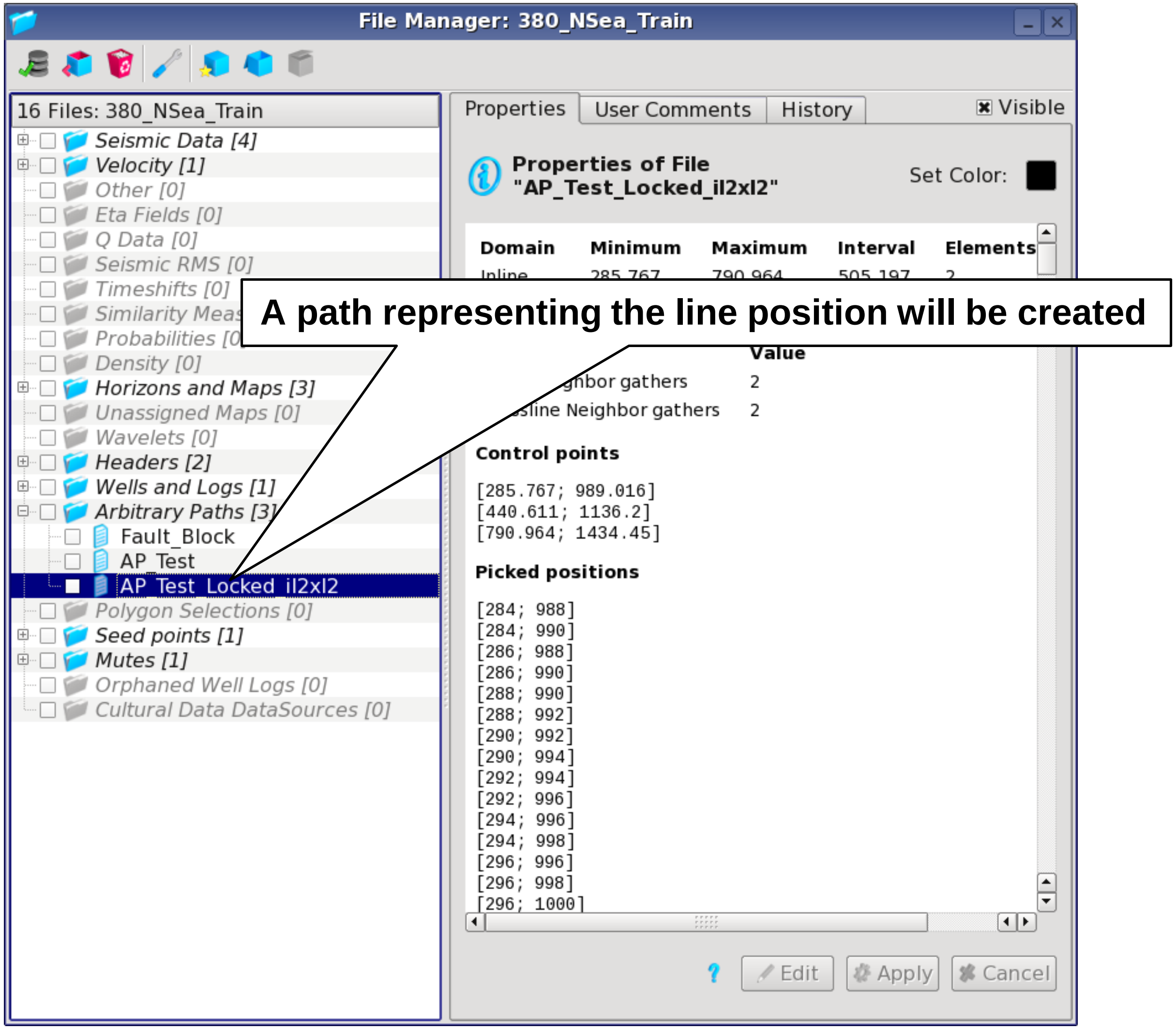
2D SEG-Y lines import



Necessary keys are:

- **Line number**
- **CDP number**
- **World X and Y coordinates**
- **Fold**

2D SEG-Y lines import



2D SEG-Y lines import

- **It is possible to import several lines as a batch**
- **The lines position can be displayed on a map using the corresponding arbitrary paths**